SCIENTIFIC AMERICAN
No. 289 SUPPLEMENT

Scientific American Supplement, Vol. XII., No. 289. Scientific American, established 1845.

NEW YORK, JULY 16, 1881.

Scientific American Supplement, $5 a year. Scientific American and Supplement, $7 a year.

CENTRAL AMERICAN ANTIQUITIES.

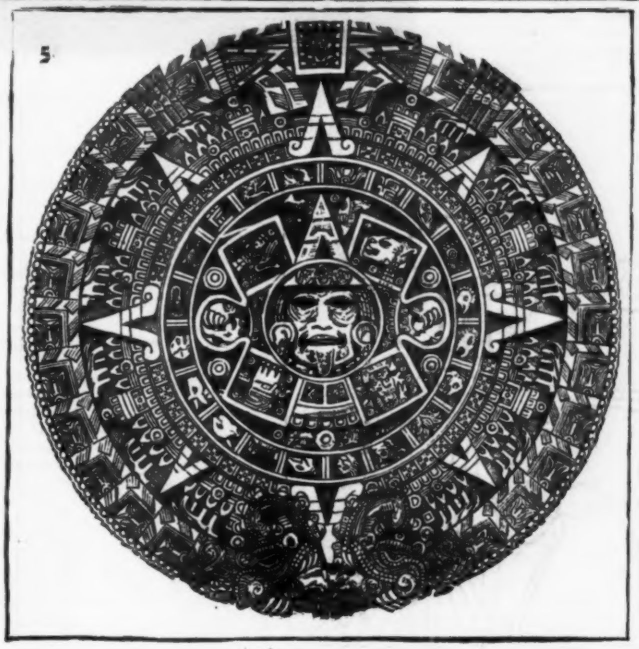
AMERICA, though styled the New World, has had an ancient civilization of its own worthy to compete with those of Egypt and Asia. Centuries before Columbus crossed the Atlantic this civilization had vanished away, and nothing now remains to tell of these bygone glories save ruined buildings upon which are inscribed hieroglyphics hitherto undecipherable. The present Franco-American expedition, however, under M. Charnay, to explore the ancient ruins of Mexico and Central America, promises to afford further knowledge of a civilization whose history has apparently been lost.

Mr. Henry Fowler, of Belize, British Honduras, who is much interested in these researches, has sent us drawings of the various kinds of antiquities which have been discovered. Some of these drawings are from photographs by Dr. Le Plongeon, who is now with the Charnay expedition in Yucatan.

No. 1 is a specimen of the picture-writing of the Aztecs, and portrays a law suit respecting an estate. It contains a complete record of the proceedings in the case. This form of picture writing, though now a lost art, was continued up to the beginning of the seventeenth century.

The Pyramid of Cholula (2) is on the high road from Puebla to Mexico. Its base is twice as large as that of the Pyramid of Cheops, and covers 44 acres. It is composed of four stories, and 120 steps lead to the platform on the top. It is constructed to correspond with the four cardinal points, and it is said to commemorate the Tower of Babel. It is dedicated to Quetzalcoatl, a great moral teacher, like Confucius and Buddha, among the Aztecs.

5



The principal colors used in these mural paintings (3) are blue and yellow, with light red for flesh tints. According to Dr. Le Plongeon the picture represents the Queen Kinich-Kakmo, when a child, consulting an astrologer as to her destiny. Her fortune is told from the lines produced by fire on the shell of an armadillo or turtle.

Among the ruins of Copan in Honduras there are many stone columns like that here represented (4). It stands with the face of a supposed idol to the eastward, and at the foot of the column is an altar. The column is 13 feet high, is sculptured on the four sides, and is covered with hieroglyphics (hitherto undeciphered), doubtless telling the history of the figures carved on the column.

The Mexican Calendar Stone (5) is a sun disk or stone of sacrifice. In the center is graven the face of a sun god, surrounded by mysterious symbols. It is 11 feet 8 inches in diameter. It was ordered to be made by a king of Mexico toward the end of the fifteenth century, was buried after the overthrow of the temple by Cortes, was accidentally dug up in the market place of Mexico in 1790, and was built into the wall of the cathedral, by order of the then viceroy.

This statue (6) is now in the inner square of the National Museum at Mexico. Chaac-Mol (the name signifies "spotted tiger") is said to have been the great warrior-chief of Chichen-Itza.

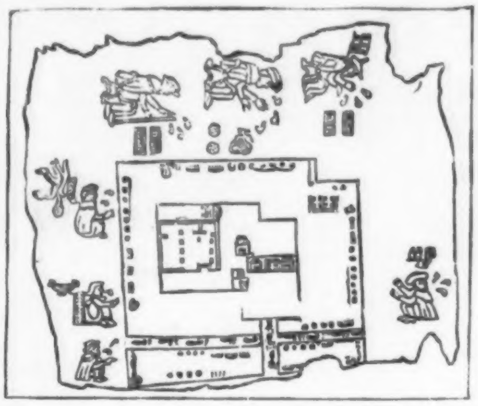
The specimen of relief in stucco at Palenque may fairly compare with the beautiful works of the Augustan age. An effigy of the sun is seen on the ornament hung round the neck.—*London Graphic.*

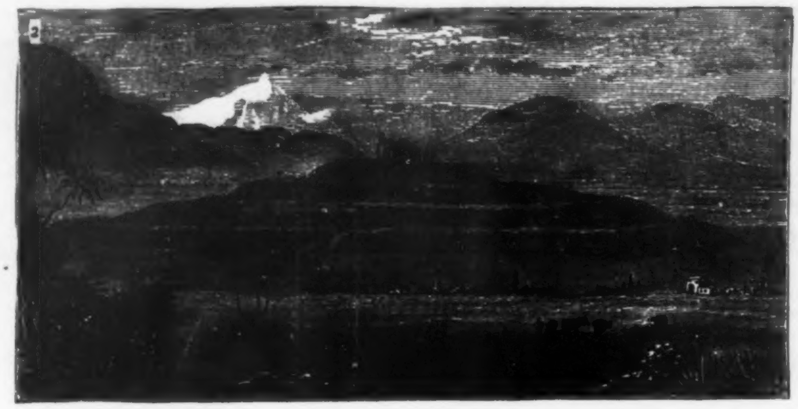
7

4

4. Stone Column found at Copan, Honduras. 5. Mexican Calendar Stone. 6. Statue of Chaac-Mol, Excavated at Chichen-Itza, Yucatan, 1875. 7. Specimen of Stucco Relief-Work found at Palenque, Chiapas.

ANTIQUITIES DISCOVERED IN CENTRAL AMERICA.





1. Aztec Mural Painting: A Law Suit. 2. Pyramid of Cholula, near Mexico. 3. Mural Painting in the Funeral Chamber of the Chaac-Mol Monument at Chichen Itza.

ANTIQUITIES DISCOVERED IN CENTRAL AMERICA.

NEWLY OPENED PYRAMIDS.

THE two newly opened pyramids of Sakkarah have just been completely described by M. Brugsch in the Egyptian Institute at Cairo. They are situated in the desert west of Sakkarah. The galleries and chambers are covered with hieroglyphics, in which the two words "Merina" and "Pepi" occur as royal names. M. Brugsch showed from the context that the two pyramids were the monuments of the two kings Pepi, and his son Horemsaf, of the sixth dynasty of Manetho. The granite sarcophagi, also covered with hieroglyphics, still stood in their old places; but of the mummies only one was found—that of Horemsaf, deprived of its ornaments and robes. The pyramids have evidently been plundered in ancient times. They are the earliest examples of royal graves in Egypt which are adorned with hieroglyphic inscriptions of a religious nature. The star Sothis—Sirius—the constellation Orion, and the planet Venus are represented. It is most remarkable that in the Cairo Museum there is a tombstone erected to the memory of a certain Una, an official at the court of King Pepi. The inscription on the stone refers to the building of the now opened pyramids of Sakkarah, which was superintended by Una.

THE BASIN OF THE GULF OF MEXICO.

By J. E. HILGARD, M.N.A.S.*

AT the meeting of the National Academy of Sciences in New York, Nov. 18, 1880, Mr. J. E. Hilgard presented, on the part of Hon. C. P. Patterson, Superintendent of the U. S. Coast and Geodetic Survey, a model of the Gulf of Mexico, constructed from numerous soundings taken in the progress of that work, the full size of which is 24×32 inches, being on a horizontal scale of 1:2,400, 00, and on a vertical scale of 1 inch: 1,000 fathoms; making the proportion of horizontal to vertical scales 1:33. On the model, the forms are shaped in conformity with all the detail obtained from the soundings, those inside of 100 fathoms being quite numerous, varying according to the configuration and importance of the locality, while beyond the 100 fathom line, where the work pertains rather to physical geography than to navigation, 1,035 soundings were obtained, of which 355 are in depths greater than 1,000 fathoms.

The object of the communication being merely to give a general description of the structural features of the basin of this great inland sea—the American Mediterranean—it is only necessary to mention here, that, in connection with the soundings, temperatures were taken at various depths, and the organic life was explored by means of dredges. Everywhere below the depth of about 800 fathoms, the temperature was found to be between 39° and 40° F. The method of sounding was by the use of fine steel wire, indicated by Sir Wm. Thomson, with the mechanical appliances perfected by Commanders Belknap and Sigsbee of the U. S. Navy.

The exploration of the Gulf of Mexico was begun by the U. S. Coast Survey as long ago as 1846, when surveys of the shores were made, and soundings of the approaches were obtained under the superintendency of Prof. A. D. Bache. These investigations continued until the outbreak of the civil war, Prof. Bache having in view, from the earliest date of his work, the exploration of the Gulf Stream and its attendant phenomena, in addition to the surveys requisite for navigation. When, after the close of the war, the Coast Survey resumed its former activity, under the administration of Prof. Benjamin Peirce, the physical and biological investigations were continued; but it was not until the present Superintendent of the U. S. Coast Survey (C. P. Patterson, LL.D.) organized a systematic exploration of the whole Gulf, that its character became rightly understood. These explorations, begun in 1872 by Commander Howell, U. S. N., on the west coast of Florida in comparatively shallow water, were continued and brought to a successful conclusion by Commander Sigsbee, U. S. N. (1875–78), in the steamer Blake, accompanied by Prof. A. Agassiz in charge of biological investigations. The methods of obtaining temperatures at great depths as well as of dredging have been described in the Coast Survey Reports for several years past, and more especially in a treatise by Commander Sigsbee recently published by the Coast Survey.

The basin of the Gulf of Mexico is an oval connected with the general ocean circulation by two outlets, the Yucatan Channel and the Florida Straits. The area of the entire Gulf, cutting it off by a line from Cape Florida to Havana, is 595,000 square miles. Supposing the depth of the Gulf to be reduced by 100 fathoms, a surface would be laid bare amounting to 208,000 square miles, or rather more than one third of the whole area. The distance of the 100 fathom line from the coast is about 6 miles, near Cape Florida; 120 miles along the west coast of Florida; at the South Pass of the Mississippi, it is only 10 miles; opposite the Louisiana and Texas boundary, it increases to 130 miles; at Vera Cruz it is 15 miles, and the Yucatan banks have about the same width as the Florida banks.

The following table shows the area covered by the trough of the Gulf of Mexico to the depths stated:

Depth.	Area.	Differences.
2,000 fathoms......	55,000 square miles.	
1,500 "	......187,000 "	132,000
1,000 "	......260,000 "	 73,000
500 "	......326,000 "	 66,000
100 "	......387,000 "	 61,000
Coast line....	......595,000 "	208,000

This table shows that the greatest slopes occur between the depths of 100 and 1,500 fathoms. The maximum depth reached is at the foot of the Yucatan banks 2,119 fathoms. From the 1,500 fathom line on the northern side of the Gulf to the deepest water close to the Yucatan banks, say to the depth of 2,000 fathoms, is a distance of 200 miles, which gives a slope of five-ninths to 200, and may be considered practically as a plane surface. The 2,000 fathom area has received the name of "Sigsbee deep," after its explorer. The Yucatan Channel, with a depth of 1,164 fathoms, has a cross-section of 110 square miles; while the Straits of Florida, in its shallowest part, opposite Jubiter Inlet, with a depth of 344 fathoms, has a cross-section of only 10 square miles.

A view of the model reveals at once some important facts which a study of the plan conveys but imperfectly to the mind, and which were unsuspected before the great exploration of the Gulf was completed.

Among the more striking features displayed by the model to which Mr. Hilgard called attention, were:

1. The great distance to which the general slope of the continent extends below the present sea level before steeper slopes are reached. The 100 fathom line represents very closely the general continental line. The *massifs* of the peninsulas of Florida and Yucatan have more than twice their present apparent width.

2. Very steep slopes lead from this submerged continental plateau to an area as great as that of the State of Georgia, at the enormous depth of over 12,000 feet. There are three ranges on the Florida and Yucatan slopes extending in the aggregate from five to six hundred miles, along which the descent from 500 to 1,500 fathoms (or 6,000 feet), is within a breadth of from six to fifteen miles. No such slopes and correspondingly elevated plateaus appear to occur on the un-submerged surface of the earth. The suggestion presents itself, that while the latter have suffered atmospheric erosion, those which we are considering have not sensibly changed from the positions assumed in the mechanical shaping of the earth's crust.

3. The far protrusion of the Mississippi Delta toward the deep water of the Gulf seems to give evidence to the engineer of the probably permanent success of the Mississippi Jetties, as delivering the silt of the river into water of so great depth that but few extensions will ever become necessary. In connection with the same feature, the strong indentation to the westward of the present mouths of the Mississippi, indicating the probable site of the original fracture between the two slopes of the Mississippi Valley, deserves attention.

4. In regard to the problem of general ocean circulation in connection with the Gulf Stream, the most important feature is the shallowness and small cross-section of the Straits of Florida between the Peninsular and Bahama banks, having at the shallowest part a cross-section of 11 square miles, with a greatest depth of 344 fathoms only. From observations published in the Coast Survey Reports the average northwardly current of the warm water through this Strait is probably not greater than 2 miles per hour—certainly not more than 2½ miles. It is evident, at once, that the warm water which so greatly modifies the climate of Western Europe, cannot all be supplied by the flow through this small channel. The concentration of the warm surface current from the Gulf of Mexico gives to this vein of the general circulation a marked velocity which is not found in other portions of the Atlantic, and which, being perceptible to the navigator, has given its name of "Gulf Stream" to the whole system of the northeasterly surface-flow in the Atlantic Ocean. It is now necessary to assume that the so called Gulf Stream is largely re-enforced by a general northerly current from the outside of the West India Islands.

* A communication to the National Academy of Sciences made Nov. 18, 1880, by authority of C. P. Patterson, Supt. U. S. Coast and Geodetic Survey.

THE FEEJEE ISLANDS AND THEIR RESOURCES.

THE following is a communication made to the Geographical Society of Antwerpen by Mr. Bernardin, its corresponding member living in the Feejee Islands.

The Feejee Islands have belonged since 1874 to England, and comprise more than 200 small islands situated in the Southern Pacific Ocean (80 of them are inhabited), between 176° east and 178° west of Greenwich, and between the 16° and 21° of S. latitude, 1,760 miles north-east of Sydney and 1,175 miles north of Auckland.

The island Viti Levu, the largest among them, is nearly as large as Jamaica; the second, Vanua Levu, is three times as large as the Island of Mauritius. The whole area of the islands amounts to 4,953,600 acres, *i. e.*, more than the whole British East India (Trinidad included). About the seventh part of the country has been explored by Europeans. The ground is chiefly volcanic, very rich and fertile, and excellently adapted for the culture of tropical plants. The country is watered by numerous rivers. The climate is very healthy, and during nine months the heat of the sun is modified by the monsoon blowing from the south-east. The average quantity of rain-fall during the year amounts to 100 to 110 inches; the average temperature is 75–80° F. Hurricanes occur during the month of March.

Population.—The islands are inhabited by 110,000 natives, 2,200 Europeans, and 350 Polynesians.

Principal Products.—Cotton, coffee, cocoa-nuts, cocoa oil, coprah cocoa-fibers, sugar, rum, maize, holothuries, tortoise shell, mother-of-pearl, tobacco, arrow-root, fruits, wood for building.

Cocoa Nuts.—Area of culture, 9,166 acres; coprah exported, to the declared value at the Custom house, 1875, $10,000.75; 1878, $30,548.5. The cocoa-nut trees take from five to seven years to produce fruit. They are planted at the rate of fifty trees per acre, producing one hundred nuts each, corresponding to one ton of coprah, valued at the plantation at $50.50; the fiber is exported in hundreds of tons to Sydney.

The Cotton is of a superior quality. Since 1872 the culture has somewhat decreased, on account of the small profits. At present it is again increasing, as the prices in the European markets are rising.

The exportations during the year amounted, in 1875, to $114,824; in 1878, to $82,800; the cultivated area having been 2,390 acres.

Sugar.—The cane is indigenous in the colony and flour-

ishes remarkably. At the exposition of Sydney, there were canes from Feejee twenty-six feet in height.

Exportations, in 1875, amounted to $854 25; in 1878, $4,660; the area of cultivation was 1,772 acres.

Coffee.—It promises to be an article of great profit. The first harvest produced from 330 to 450 lb. per acre; the area of cultivation is 1,219 acres.

Arrow-root.—It is of an excellent quality; the plants come from Bermudas (*Maranta arundinacea*); they were sold in London in 1879 at ten cents per pound.

Tobacco.—The quality is excellent; 2,500 acres are cultivated and exported to New Zealand.

Wood for Building Purposes.—Dakua (*Dammara vitiensis*), Dilo (*Calophyllum inophyllum*), Damanua (*calophyllum spectabile*), Vesi (*Afzelia bijuga*), etc.

Trials were made in the cultivation of cacao, quinquina (peruvian bark), vanilla, etc., and also in the extraction of the oil of the candle-nut (*Aleurites*) and of Dilo (*Calophyllum inophyllum*).

Communications.—A steamer subsidized by the government visits the principal islands every month; there is besides a flotilla of seventy small crafts engaged in the inter-insular commerce.

Every month a subsidized steamer leaves for Sydney. The trip takes seven days, while it takes eight weeks for a steamer to go from Feejee to Great Britain. Communications are also established between Feejee and Melbourne, by steamer, and some recently built crafts go to New Zealand and Australia.

[FROM NATURE.]

ROBERT WILHELM BUNSEN.

THE value of a life devoted to original scientific work is measured by the new paths and new fields which such work opens out. In this respect the labors of Robert Wilhelm Bunsen stands second to those of no chemist of his time. Outwardly the existence of such a man, attached, as Bunsen has been from the first, exclusively to his science, seems to glide silently on without causes for excitement or stirring incident. His inward life, however, is, on the contrary, full of interests and of incidents of even a striking and exciting kind. The discovery of a fact which overthrows or remodels our ideas on a whole branch of science; the experimental proof of a general law hitherto unrecognized; the employment of a new and happy combination of known facts to effect an invention of general applicability and utility; these are the peaceful victories of the man of science which may well be thought to outweigh the high-sounding achievements of the more public professions.

Prof. Bunsen is eminently a soldier of science, his devotion to his flag has been unwavering and life-long, and his whole existence has been a noble struggle for the mastery of nature's secrets. Born on March 31, 1811, at Göttingen, where his father was Professor of Theology, Bunsen graduated in that ancient university before he had passed through his teens, and published an inaugural dissertation, "Enumeratio ac descriptio hygrometorum." Soon afterwards, at the age of twenty-two, he became a privat-docent at the university of his native town, thus entering the career of a teacher, which he has consistently followed with conspicuous success for close on half a century. In 1836 Bunsen became professor of chemistry at the Polytechnic School in Cassel; in 1838 he was appointed to the chair of chemistry in the University of Marburg, where he remained for thirteen years; afterward he was for a short time at Breslau, whence he removed to Heidelberg, of which renowned university he has been one of the chief ornaments and attractions for the last thirty years.

Bunsen's first scientific investigation was one which attracted general attention, and the results of which are of permanent importance. In conjunction with Berthold, a colleague at Göttingen, he showed that moist freshly precipitated ferric hydroxide acts as a certain antidote in cases of poisoning by arsenic, provided that it is exhibited in sufficient quantity and early enough in the history of the case. The explanation of this action is the formation of an insoluble ferrous arsenite; 100 parts of the dry hydroxide carry down from five to six parts of arsenic. So well known and valued is this antidote in Germany, that it is kept by apothecaries ready for use.

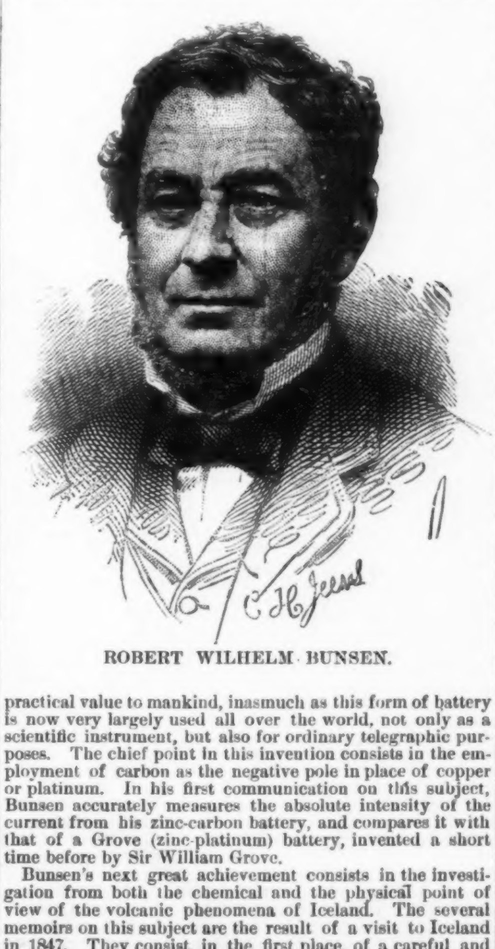
In 1835 Bunsen described some singular compounds which the double cyanides form with ammonia. He contradicted the general statement that ammonium ferrocyanide is formed by boiling prussian blue with ammonia; but showed that it is formed by digesting lead ferrocyanide with ammonium carbonate. He also measured the angles of crystals of many of the double cyanides.

In 1837 he struck the first note of one of his most important and fruitful investigations in a memoir on the existence of arsenic as a constituent of organic bodies. In the year 1760 the French chemist Cadet had observed that a mixture of acetate of potash and white arsenic yields, when heated, a heavy brownish-red liquid, which has a frightful smell and fumes strongly in the air, and this liquid was termed Cadet's fuming arsenical liquid. Little more than the fact of its existence was ascertained concerning this body until Bunsen undertook its examination, and in a series of memoirs which have now become classical, and which extended over many years, placed its composition in a true light, thus giving to the world the first member of the now well-known family of the organometallic bodies.

Bunsen showed that Cadet's liquid, as well as its numerous derivatives, contains a radical having the formula C_2H_6As, and that this substance in its chemical relations exhibited striking analogies with a metal, being indeed, as he terms it, "a true organic metal." He succeeded in isolating this body, and this discovery formed not only the starting-point for the preparation of hundreds of other similar bodies, but also contributed largely to the development of one of the most important of our chemical theories, that of compound radicals. This body, like most of its compounds, possesses a most offensive odor, so much so that the air of a room containing a trace of the vapor is rendered absolutely unbearable. Hence to this substance Bunsen gave the name of cacodyl (*kakodēs*, a bad smell). Not only however are these compounds unpleasant, but they are highly poisonous, very volatile, dangerously explosive, and spontaneously inflammable. It is difficult enough nowadays for a chemist to work with such substances armed as he is with a knowledge of the danger which he has to encounter as also with improved appliances of every kind to assist him in overcoming his difficulties. But Bunsen forty years ago was a traveler in an unknown and treacherous land, without sign-posts to guide him, or more assistance on his journey than was furnished by his own scientific acumen and his unfaltering determination. Nor did he escape scot-free from such a labor, for in analyzing the cyanide of cacodyl the combustion tube exploded. Bunsen lost the sight of an eye, and for weeks lay between life and death, owing to the combined effects of the explosion and the poisonous nature of the vapor. "This substance," he writes, "is extraordinarily poisonous, and for this reason its preparation and purification can only be carried on in the open air; indeed, under these circumstances it is necessary for the operator to breathe through a long open tube so as to insure the inspiration of air free from impregnation with any trace of the vapor of this very volatile compound. If only a few grains of this substance be allowed to evaporate in a room at the ordinary temperature, the effect upon any one inspiring the air is that of sudden giddiness and insensibility, amounting to complete unconsciousness."

Taking a totally different direction, Bunsen's next important investigations were concerned with the examination of the chemical changes which occur in the blast-furnace. In 1838 he proved, by accurate analyses of the gases escaping, "that at least 42 per cent. of the heat evolved from the fuel employed is lost, and that in view of the ease with which such combustible gases can be collected and let off to a distance for subsequent use, a new and important source of economy in the iron manufacture is rendered possible." This research is, however, not only noteworthy as pointing the way to a method of economical working without which probably but few ironmasters at the present day could exist, but also as being the first experiment in which an accurate method of gas analysis was employed. This important branch of analytical chemistry has been created and brought to its present wonderful degree of precision solely by the head and hands of the Heidelberg experimental philosopher. Simplicity and accuracy constitute the rare merits of Bunsen's system of gaseous analysis. To have gone completely through his course of gas analytical manipulations from the sealing-in of the platinum wires in the eudiometer to the absorption and explosion analyses of the Heidelberg coal-gas, under the eye and with the guiding help of the hand of the master, is in itself an experimental education of no mean order. But it is only on reference to his "Gasometric Methods" that we learn the general adaptability of this marvelously accurate system to all those numerous problems in which the analysis of a mixture of gases is required.

Next in order (1841) comes the invention of the Bunsen battery, an invention which has proved of the greatest



ROBERT WILHELM BUNSEN.

practical value to mankind, inasmuch as this form of battery is now very largely used all over the world, not only as a scientific instrument, but also for ordinary telegraphic purposes. The chief point in this invention consists in the employment of carbon as the negative pole in place of copper or platinum. In his first communication on this subject, Bunsen accurately measures the absolute intensity of the current from his zinc-carbon battery, and compares it with that of a Grove (zinc-platinum) battery, invented a short time before by Sir William Grove.

Bunsen's next great achievement consists in the investigation from both the chemical and the physical point of view of the volcanic phenomena of Iceland. The several memoirs on this subject are the result of a visit to Iceland in 1847. They consist, in the first place, of a careful and extended series of analyses giving the average composition of the volcanic rocks of different ages occurring in the island, upon which he founded a most important and very general theory of volcanic action, a theory which he has since proved is applicable to the formation of other volcanic rocks of widely different origin, both as regards time and locality. This theory consists, to begin with, in a proof that all the Icelandic rocks, of whatever age, may be considered as mixtures in varying proportions of two normal silicates, the trachytic and pyroxenic. In the first of these (an acid silicate) the relation of the oxygen of the acid to that of the bases is as 3 : 0·596, while in the latter (a basic silicate) the relation is as 3 : 1·998. This result, accompanied by an experimental proof that the melting point of different bodies is differently raised under increase of pressure, led Bunsen to assume that a crystallization of these two normal silicates occurs in the earth's interior, and that all the eruptive rocks which reach the surface consist either of one or other of these or of mixtures of the same. In the next place they contain a full and successful research on the so-called pseudo-volcanic phenomena of Iceland, in which he investigates the formation of zeolites and other crystalline minerals by the joint action of heat, acid gases, and moisture on the volcanic rocks. He also examines the composition of the fumarole gases as well as those issuing from the crater of Hecla, and explains the nature of the changes effected by these gases on the surrounding rocks. Lastly, he investigates the far-famed Great Geyser, and places the cause of the periodic eruption of boiling water on its true physical basis. His accurate observations on the spot, first as to the construction of the geyser tube, then as to its mode of formation, and finally, his thermometric measurements of the temperature of the water-column taken a few moments before the eruption and at different depths, disposed once for all of what may be called the old tea-kettle theory, and showed indisputably that in no part of the tube did the water reach the temperature of ebullition under the pressure of the superincumbent column while the column is quiescent, but that when the geyser column is elevated by the rush of steam from the volcanic vents at the bottom, the boiling-point of the water at each point of the column thus raised is reached, and "the whole mass from the middle downward suddenly bursts into ebullition, the water above mixed with steam-clouds is projected into the atmosphere, and we have the Geyser eruption in all its grandeur. By its contact with the air the water is cooled, falls back into the basin, partially refills the tube, in which it gradually rises, and finally fills the basin as before. Detonations are heard at intervals, and risings of the water in the basin. These are so many futile attempts at an eruption, for not until the water in the tube comes sufficiently near its boiling-point to make the lifting of the column effective can we have a true eruption" (Tyndall).

To do justice to all the contributions with which Bunsen has enriched our science would fill several numbers of *Nature*, and to many of them the writer must content himself with a mere cursory reference. One of his favorite and fruitful themes was the preparation by electrolysis of the rarer or more difficultly procurable metals. This is one of the purposes for which he employed his battery. Metallic magnesium was one of the first of his preparations of this kind, and in the description of this preparation his fertility of resource is clearly seen. Metallic magnesium in the molten state is specifically lighter than the fused mixture of salts from which it is obtained. Hence as soon as a globule of the metal is formed, it rises to the surface, and there takes fire and burns. To obviate this difficulty the carbon pole on which the metal was formed was serrated, and the metal on rising was caught below the surface of the fused salt in one of a series of small pockets, and thus prevented from burning.

Then followed the reduction of chromium, aluminum, and, in conjunction with the late Dr. Matthiessen, that of the alkaline-earth metals, and more recently, with Hillebrand and Norton, of the metals of the cerium group. These electrolytic researches are marked with the thoroughness and completeness which is characteristic of all Bunsen's works. He seeks for the explanation of the fact that hitherto the reduction of these metals by the electric current had proved a failure, and he finds it in what he terms the density of the current, *i. e.*, the electromotive force divided by the area of the pole, the power of the current to overcome chemical affinity increasing with its density. Thus if a constant current be led through an aqueous solution of chromic chloride, the result as to whether hydrogen is evolved, and oxide of chromium, or whether metallic chromium is deposited, depends upon the area of the pole through which the current passes into the liquid.

Nor were these experiments made merely for the purpose of preparing the metals in question. Thus the metallic magnesium was pressed into wire and used in one of the series of photo-chemical researches, to which reference will hereafter be made, for the purpose of drawing an interesting conclusion respecting its lightgiving power on combustion, and comparing this with the visual and chemical brightness of the sun, a comparison which led to the commercial manufacture of this metal by the Magnesium Metal Company, and to the wide distribution and general use of this metal as an illuminating agent of great brilliancy. Thus again the electrolytic preparation in the Heidelberg laboratory of coherent masses of cerium, lanthanum, and didymium, had the further object of the determination of the specific heat of these metals by help of the now well-known method with Bunsen's ice calorimeter, by means of which determination the true atomic weights of these metals and the proper formulæ of their oxides and compounds have been definitely ascertained.

The Bunsen battery has, however, not only been of service in inorganic chemistry, but has thrown clear light upon the constitution of organic bodies. The classical researches of Kolbe on the electrolysis of acetic acid and the other fatty acids were carried out in the Marburg laboratory, and owe their inspiration to Bunsen. The subsequent equally important labors of Kolbe and Frankland, and those of the latter chemist alone, on the isolation of the organic radicals, have a like origin.

Among the numerous physico-chemical investigations which Bunsen has carried out, none perhaps show more clearly the fertility of his experimental ability than the one in which he describes the ice calorimeter, and another devoted to an explanation of a new method of determining vapor densities. Translations of these memoirs are found in the *Philosophical Magazine* for 1867 and 1871, and may be taken as typical of his calorimetric researches.

Another group of researches is formed by those which are closely related to his gasometric methods. One of the most interesting and important of these refers to the law of absorption of gases in water. This subject was first examined by Dalton and Henry at the beginning of the century, and the well-known law which gases follow in absorption is known by the names of these two Manchester philosophers. But although generally admitted, its limits of error had not been ascertained, and the crude experimental methods of the year 1803 required to be replaced by the refined ones of the latter half of the century. These researches, carried on by Bunsen and by several of his pupils, proved that Henry's law of direct—as well as that of Dalton of partial—pressures is exactly true within certain limits, but ceases to be so beyond a given increase of pressure, while some gases which obey the law at one temperature do not do so at others, and some again while obeying it in the pure state, do not do so when mixed with other gases.

The mere mention of his other researches in the wide field of gaseous chemistry is sufficient to indicate his devotion to this branch of experimental inquiry. We find experiments on laws of gaseous diffusion, on applications of gaseous diffusion in gasometric analysis, on the phenomena of the combustion of gases, on the temperature of ignition of gases, and all these, be it remembered, involving exact measurement, and in many cases elaborate calculations.

Brief reference must next be made to a series of investigations in a totally different direction, viz., on the measurement of the chemical action of light, with the carrying out of which the writer of this article had the great good fortune and pleasure to be connected, and in which he had full opportunity of admiring Bunsen's untiring energy and wonderful manipulative power. In all the difficulties and perplexities by which the experimental investigation of such a subject is beset, the writer never knew Bunsen discouraged

or at a loss for an expedient by which an obstacle could be overcome. Cheerful and self-reliant under the most depressing circumstances, he never gave up hope, and thus it was that these somewhat intricate and difficult investigations were brought to a successful close.

Again, in the department of analytical chemistry how numerous and valuable have been his contributions! There is scarcely one important problem in this subject which has not benefited from his extensive experience and keen insight. Bunsen's methods of silicate analysis, of mineral water analysis, and a dozen of other complicated laboratory processes, are simply perfect. Then his original method for the estimation of nitrogen in organic bodies will always be remembered as one of the most accurate of its kind when employed by an experimentalist as expert as Bunsen himself, but as most difficult and even dangerous in less able hands. Again, all chemists use and appreciate the much simpler methods for the estimation of nitrogen and sulphur admirably worked out by his pupils—Maxwell Simpson and Russell.

We all employ his beautiful general method of volumetric analysis, but chemists do not always remember that in this research Bunsen first determined the exact percentage composition of the higher oxide of cerium, a determination of the greatest scientific importance as regards the chemistry of the metals of the rare earths. Moreover they may be apt to forget that Bunsen was the first to introduce a general method of the separation of these rare earths, by which he for the first time prepared pure yttria and erbia, and by which subsequently, in the hands of other chemists, many new metals have been discovered. His well-known method of flame-reactions is a standard example worked out by every student. Again, modern chemists can now scarcely carry on the simplest experiment without using the "Bunsen gas-lamp," a burner which is also now employed in every household, and in many manufactories, and has become so necessary that it is difficult to conceive how we worked before its invention. To him we are also indebted for the apparatus for accelerating filtration, the "Bunsen-pump," together with all its appliances, now employed in every laboratory.*

Of all the contributions to the advancement of our science, that by which the name of Bunsen has, however, become best known, and by virtue of which future generations will place him on the highest pinnacle of experimental fame, is the foundation, with his no less celebrated colleague Kirchhoff, of the science of spectrum analysis, and the discovery by its means of the two new alkali metals, cæsium and rubidium. It is true, of course, that many facts were ascertained and many observations made relating to the power possessed by matter in the state of incandescent gas emitting rays of a peculiar and characteristic kind. Few great discoveries are made at one step. But the glory of having established a new branch of science, of having placed "analysis by spectrum observations" on a sound and firm experimental basis, belongs to the Heidelberg philosophers, and to them alone.

The history of the establishment of spectrum analysis, as that of its enormous recent developments, is too well known to the readers of *Nature* to require repetition. All that is necessary here is to recall the masterly way in which Bunsen worked out the properties and showed the relationships of the new metals and their compounds. He first saw the cæsium lines in a few milligrammes of the alkaline residue obtained in an analysis of the Dürkheim mineral waters, and the discovery of a second new metal (rubidium) soon followed that of the first. So certain was he of the truth of his spectroscopic test that he at once set to work to evaporate forty tons (44,000 kilos) of the water, and with 16·5 grammes of the mixed chlorides of the two new metals which he thus obtained, he separated the one metal from the other (no easy task) and worked out completely their chemical relationship and analogies, so much so that the labors of subsequent experiments have done little more than confirm and extend his observations; such a result is truly a marvel of manipulative skill!

Another less widely known, but no less interesting and important research, is that on the spark-spectra of the metals contained in cerite and other rare minerals. In this he shows his power both as physicist and chemist. He first describes a new chromic-acid battery suited to the performance of the special experiments which he afterwards details. He determines with great care all the physical constants of this battery, and then proceeds to investigate the spectra of the earths which give no color to the non-luminous flame. The spark-spectra of these earths he carefully maps, so completely, indeed, that the separation and identification of these metals now for the first time became possible.

The many hundreds of pupils who, during the last half-century, have been benefited by personal contact with Bunsen, will all agree that as a teacher he is without an equal. Those who enjoy his private friendship regard him with still warmer feelings of affectionate reverence. All feel that to have known Bunsen is to have known one of the truest and noblest-hearted of men.

H. E. Roscoe.

JEAN LOUIS BAUDELOT.

Jean Louis Baudelot was born at Vendreese (Department of Ardennes), France, on the 19th of March, 1797. His father, a well educated man for that time, was a director of blast furnaces and very expert in his profession. In the year 1806 the family removed to Harancourt, where M. Baudelot had been called to superintend the blast furnaces of M. Fort. From the age of eleven years the boy was associated in the work of his father, and it was his particular duty to remain in charge of the furnaces during the night. The long watches were passed in instructing himself by reading valuable books taken from his father's library. His only illumination was the light from the tuyeres. At so young an age his desire to investigate and his astonishing sagacity had already been observed. It was sufficient for his father to mention in his presence some difficulty which he had encountered, when immediately his active imagination would set to work, and rarely would the problem be incorrectly solved. When he was nineteen, while working in a distillery which his father had established, he devised an apparatus which carries the steam directly from the generator in the midst of the materials which were being distilled in the caldron. By this means all danger of explosions, which up to that time had been of frequent occurrence, were removed, and a very great economy of fuel resulted from the employment of his invention. This was, for that time, an immense stride forward in that industry, and it was not till some years later that it was successfully improved by others. In 1834 he secured a patent on a process for the saving and utilizing the escaping gases which passed into the air from the throat of the blast furnace. His method is now employed at all of the blast furnaces on the globe—in India as well as in America and Europe. "This, according to the most competent men, is, next to the steam engine, the most beautiful and useful invention of this century." The economy resulting from its employment can only be estimated by millions. Numerous other inventions of metallurgical importance were devised by Baudelot. In February, 1856, he obtained a patent for a tubular cooler, which, with the aid of his son, he had invented for the purpose of cooling beers and the sweet juices made in breweries and distilleries. This invention has completely changed these industries, and its use very soon spread over all parts of the world. He obtained, in 1862, a patent for the invention of a machine to be used in washing barrels. It works automatically, by means of a crank. This invention has also been successfully introduced in the industries just referred to.

About the same time he invented the metallic false bottoms which are cast in sections and placed in the mashtuns of breweries and distilleries. This soon superseded the wooden ones, which give rise to mouldiness and putrid fermentations, so objectionable in their effects to brewers. Such is a brief summary of the life-work of an individual who continually sought the welfare of his fellow beings by improving the methods which were employed in the various industries. All of his discoveries are remarkable for their extreme simplicity. It is not our province to comment on his private life, and we content ourselves with the simple observations that he was considered the type of a virtuous man; a deep sense of duty was ever his guide. Full of years he died on the 9th of January, 1881, causing an irreparable void and mourned by his descendants of three generations in addition to the world at large.

* Mr Sprengel has protested against this assignment of his invention, the well known Sprengel pump, stating that Prof. Bunsen himself has fully credited it to him, Mr. Sprengel.

TESTING EXPLODED BOILER PLATES.

This subject seems to me, when considered with reference to arriving at the truth by those who are without prejudice, and have no opinions or theories to sustain and no self-interests involved, to be of sufficient importance to warrant me in suggesting a few more thoughts on the subject of a proper method of investigating boiler accidents. While I am as far as possible from a desire to disparage thorough and exhaustive tests of the materials of which any exploded boiler is composed, however trivial the loss or damage resulting from the explosion may be, and believe in unrestricted criticism of objectionable forms and workmanship, still I think that the methods usually employed in the investigation, and the expressions used by experts in explaining the causes of the explosion, are but partially understood by the average boiler owner. I believe that persons who generally undertake these investigations and explanations, however honest they may be in their convictions and intentions, are sometimes unconsciously led into errors from lack of experience, not as practical mechanics or men of good common sense, but as investigators of this peculiar class of accidents, or from an honest belief that they possess *the* panacea for all boiler maladies in the shape of some patent device for effecting both safety and economy in the use of the steam generator. It is too often the case that those who are called on by coroners to give opinions have some standard theory which they conceive must apply to all cases, since they may never have seen a well-defined exception. Their opinions are made up from their own very limited observation of destructive explosions, together with what they may have gleaned of unreliable details of a goodly number that have been published in the local papers, or from the evidence of astonished eye-witnesses who happen to be within seeing distance, and who are mostly not the class of persons whose statements should be relied on, more especially if those statements tend to obliterate the true and accepted connection between cause and effect. When we accept such statements as the truth, nothing is more natural than to set about inventing a theory by which to account for the astonishing results. The only really reliable witnesses are the mute fragments at the scene or in the vicinity of the accident; and I believe if they are questioned aright we may be sure of a reliable and satisfactory answer. Let us consider a case that is neither rare nor exceptional, but is, with but slight variations in detail, of rather common occurrence.

We have, for instance, an exploded horizontal tubular boiler—a type of boiler well known to the readers of the Scientific American, and, in fact, known to most steam-users in this country. We find a girdle of the shell, comprising the second and part of the third ring of sheets from the front, torn off and flattened out, which has been thrown considerable distance, and the whole cluster of tubes separated from the front head, which was nearest to the opening and which is thrown a less distance. The tubes all remain attached to the back head, as well as the remainder of the shell; these are found nearly in the line of their projected normal axis at a much greater distance from its original site than any of the other parts. On examination we are unable to detect any general weakness in the fastening of the tubes to the front head, from which they have all parted, beyond what appears in the fastenings of the tube to the back head, to which they all remain attached. Some of the tubes—those in the outer part of the cluster—are bent outward to regular curves like staves at the bulge of a cask, the summit of the curves being nearly opposite the middle of the opening in the shell; in addition to this regular curve, some of them are bent at a sharp angle opposite to the torn edge of the shell, to which they still remain attached by means of the back head.

We have previously settled beyond any reasonable doubt that there was neither low water nor excessive pressure in this case; the former by the absence of burned plates or tubes and by the presence of a good fusible plug in the rear head, and the latter by the well established fact of the proper condition and ample capacity of the safety valve, together with the testimony of all the surviving workmen and the neighbors that the mill was at full work at the moment of the accident, while we know that this work called for nearly the full capacity of the boiler, so that an accumulation of pressure while running would seem to be out of the question. The questions that now seem pertinent are: (*a*) Were the operations that produced these phenomena exactly simultaneous? (*b*) Must not some one of them have preceded the others, as the breaking of the cap precedes the discharge of the gun? (*c*) Did the head part from the tubes before the shell sheets were torn off, and, if so, would the tubes, then free at one end, have been bent as we find them, or could the force remaining within the shell, now freely open by the loss of the front head, have been sufficient to burst the shell and flatten out the girdle? (*d*) If the shell burst first, could the other operations follow, and all within the fraction of a second of time, and would they *naturally* follow?

The testing machine does not seem to answer these questions, though it has done its full duty in showing us that the strips cut from the broken as well as the unbroken plates had a fair tensile strength, and other such desirable qualities as may be expected to exist in iron that has been subjected to varying strains and temperatures for years; furthermore, it has the usual thickness found in cylinders of this size, and it would, if sound throughout, have borne a pressure at least three times as great as we have good reason for believing it endured at the moment that it gave way. We seem, then, to be in the presence of a dilemma with a single pair of horns, on one of which is inscribed MYSTERIOUS AGENCY, which caused the simultaneous breaking of the boiler on all these lines, and on the other UNDISCOVERD WEAKNESS. As the former is quite unlikely to lead to a satisfactory solution, I prefer to hang my faith on the latter horn, and commence systematically to follow the clew, and I hope you will allow me space in your next issue to give you the result of the search.—*S. N. Hartwell, M.E.*

A SIMPLE GAS MOTOR.

Efforts have been for several years directed towards improving the gas motor so as to furnish persons having need of a small motive power with an apparatus that shall be inexplosive, easily managed, and readily and cheaply installed anywhere that may be desired.

Mr. Edward Benier, of Beaumetz-les-Loges, has invented a new motor of this kind which is extremely simple and takes up much less room than other machines for the same purpose. The apparatus, which is shown in the accompanying cut, may be affixed to the floor, to the workbench, to a cast-iron or a stone base, by means of four screws, and be connected with the gas pipe by means of rubber tubing.

The cylinder, which is horizontal, is surrounded by a receiver into which a few pints of water are poured. To start the machine it is only necessary to light a small burner located externally, and afterwards give the fly-wheel an impulse with the hand. The piston-rod puts in motion a side lever with which is articulated the connecting rod that actuates the crank. The water which is poured in at the beginning evaporates very slowly. It suffices, according to

BENIER'S GAS MOTOR.

the size of the machine, to replace the water lost, by from half a tumblerful to a pint every morning.

The motor is very quickly and easily taken apart. For this reason every portion of it may be thoroughly cleaned every day, and very little oil need be used. By varying the amount of gas used the speed may be correspondingly varied from 60 to 160 revolutions per minute—except in the very small sizes, where the speed ought not to exceed 120 revolutions. The largest size of these machines has a power equivalent to 1½ kilogrammeters; it weighs only 55 lb., and consumes about 6 cubic feet of gas per hour.

AN IMPROVED DREDGER.

WE give below an illustration of Bruce and Batho's dredger, recently constructed by Messrs. Hawks, Crawshay & Sons, of Gateshead-on-Tyne, for Messrs. Smith, Forrest & Shade, the contractors for dredging the port of Bilbao. The vessel is 105 ft. in length, with a moulded breadth of 23 ft., and a depth of hold of 9 ft. It is propelled by compound surface condensing engines, having a high-pressure cylinder 13½ in. diameter, and a low-pressure cylinder 25 in. diameter, with a stroke of 21 in., and provided with all the requisite feed, bilge, and circulating pumps complete; these engines take their steam from a multitubular boiler of the return flue type.

The dredging apparatus consists of a single excavator having a diameter of 8 ft., and capable of raising from 7 tons to 10 tons of *débris* per lift, according to the nature of the material operated upon.

The excavator is carried in a universal joint at the end of a balanced beam, and is closed in performing the operation of digging, and opened for the purpose of discharging by hydraulic rams, these rams working in opposite directions in one cylinder provided with an upper and lower compartment. The crossheads of the rams are connected by means of strong tie bolts, the lower crosshead in its turn being connected by links to the arms of the excavator. The water from the pressure pumps is passed through the trunnions of the cast-steel ring of the universal joint to the trunnions of the excavator cylinder, whence it is conveyed to the upper and lower compartments of that cylinder.

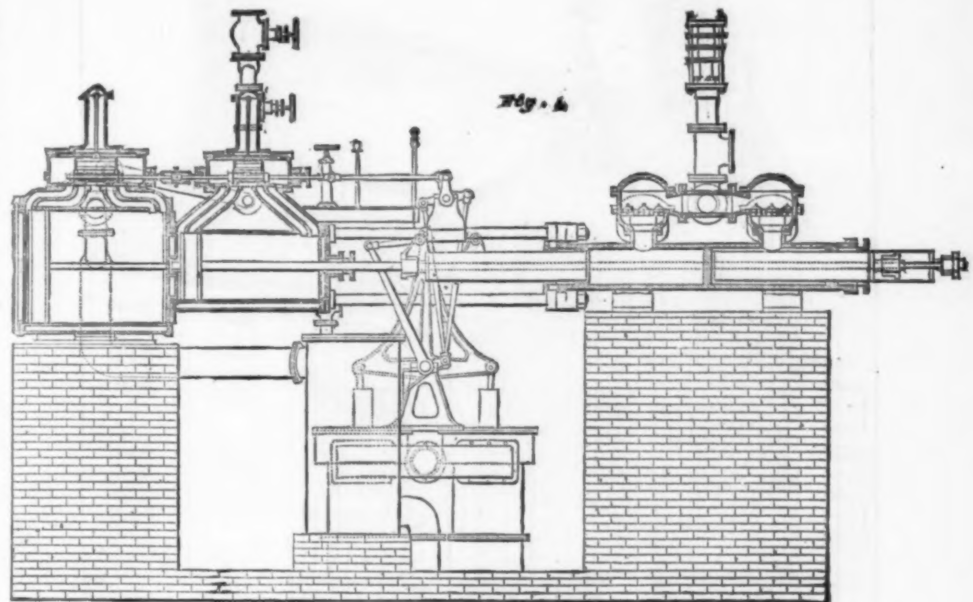
This apparatus is arranged to dredge to a depth of 21 ft. below the surface of the water, and the whole of the travel from the bed of the river to the level of discharge is performed by the main beam, while in order to reduce as much as possible the versed sine of the arc described by this beam, it has been centered on a rocking lever, and provided with a radius link connected to the vertical framing. The main beam is raised and lowered by single-acting rams placed on either side of it; the crosshead fitted to these rams is connected by links to the beam, and the after end of the beam is provided with a cast-iron weight to counterbalance the dead weight of the excavator.

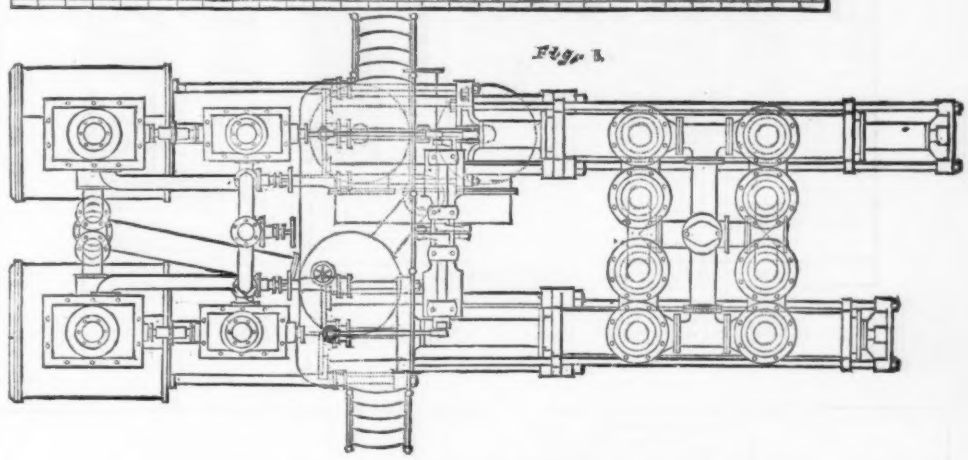
The *débris* is discharged on a hinged tray which is fastened to the beam by chains, and is thereby automatically lowered and raised beneath the excavator to receive the spoil which is subsequently shot into barges.

The hydraulic pressure is derived from one of Messrs. Easton & Anderson's duplex pumping engines, having two steam cylinders 16 in. in diameter and 27 in. stroke, this engine working two differential pumps, whose plungers are connected to the piston rods of the steam pistons; these pumps are capable of delivering 20 cubic feet of water per minute at 1,000 lb. per square inch. On the completion of the dredger we have been describing it was thoroughly tested in the Tyne with very satisfactory results.—*Engineering.*

WORTHINGTON COMPOUND PUMPS.

AT the Albany and Rensselaer Iron and Steel Works there are two large Worthington compound duplex pressure pumps. The larger one is illustrated by Figs. 4 and 5. It has a pair of 21 inch and a pair of 36 inch steam cylinders, and four 9½ inch plungers, with 3 feet stroke. The smaller has 33¾ inch and 19¼ inch steam cylinders, 9 inch plungers, and 24 inch stroke. The Cornish engine produces perfect uniformity of pressure during its stroke, by means of a weight which falls only as fast as the water can get out of its way at a uniform pressure. A flywheel action, on the contrary, forcibly changes the velocity of the water column at different parts of the stroke. The Cornish engine, however, is imperfect, in that it allows the water column to stop at the end of the stroke, and for this reason it cannot, and in practice does not work smoothly, up to its capacity, without a stand-pipe. The Worthington duplex, being without flywheel action, has the two great advantages of the Cornish engine; 1st, it, so to speak, sympathizes with the disinclination of the water to move, instead of forcing it to move in accordance with the requirements of a flywheel; 2d, its valves have time to come to rest at the end of the stroke as follows: Two steam pumps are placed side by side, and so combined as to act reciprocally on the steam valves of each other. The one piston acts to give steam to the other, after which it finishes its own stroke, and waits for its valve to be acted upon before it can renew its motion. This pause allows all the valves to seat quietly, and prevents concussion. Thus the delivery of the duplex is continuous, and the pressure on the delivery pipe does not fluctuate. No less than four Cornish engines, so arranged as to represent the four strokes of the duplex, would give precisely the same uniformity of delivery.—*Engineering.*



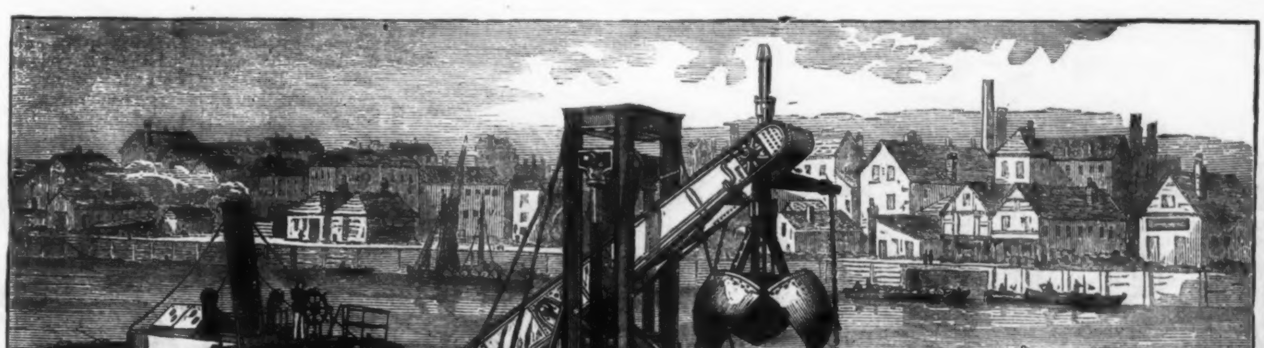


WORTHINGTON COMPOUND PUMPS.

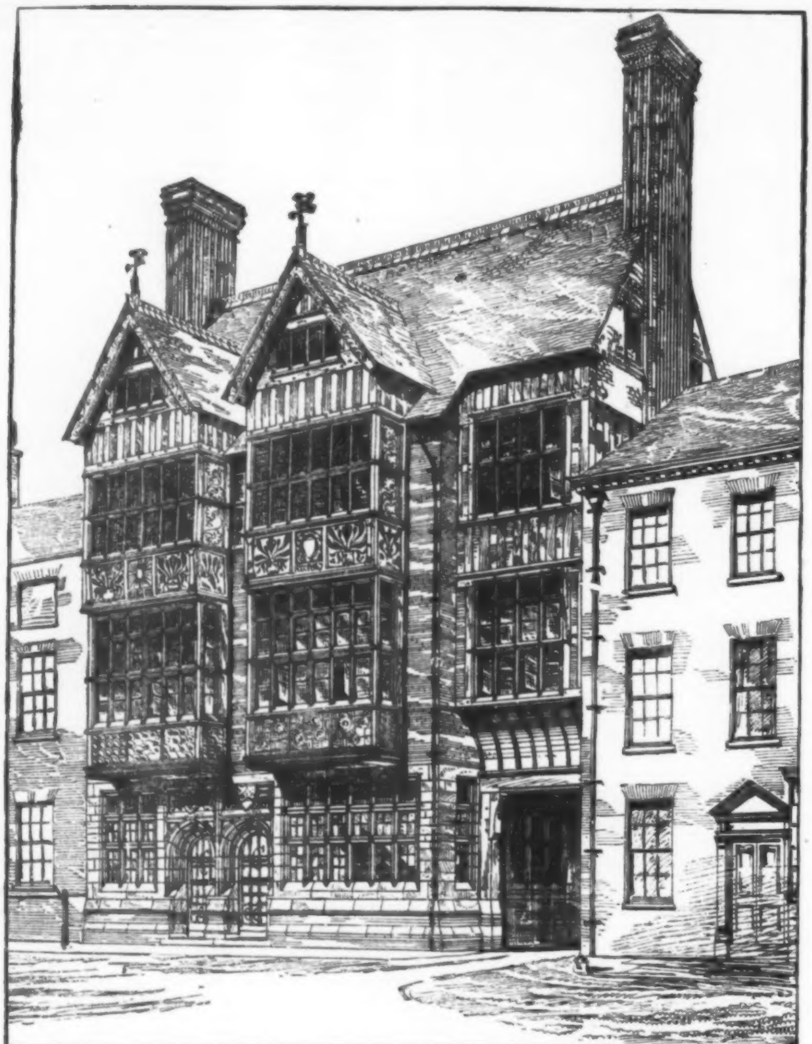
WOODEN PAVEMENTS IN SAN FRANCISCO.

WOODEN pavements are peculiarly ill adapted to the climate of California. During the long, dry summers the wood shrinks, and the spaces between the shrunken blocks get filled with sand. With the first fall of rain the wooden blocks expand, and something must give way. Usually the roadway humps itself into ridges impassable to wagons. Frequently the ridges break up with the pressure, and street urchins carry off the detached blocks of wood for fuel.

A TRAIN of fifty car loads of oysters in barrels passed through Chicago the other day, en route to San Francisco. They were to be planted in the bay near that city. They were shipped thither by A. Booth, the great Chicago oyster man, who has extensive oyster beds near San Francisco, which he has cultivated very successfully for several years.



IMPROVED DREDGING BOAT.



View: of: New: House: FARNHAM: for: James: Knight: Esq: NESFIELD & SHAW, ARCHITECTS.

SUGGESTIONS IN ARCHITECTURE.

SUGGESTIONS IN ARCHITECTURE.

WE give from the *Building News* a perspective of a new house at Farnham, England, which presents a very quaint and striking appearance.

We also give an English prize medal design for a homestead and milk establishment for fifty cows; Richard Waite, architect.

AMERICAN MILLING.

By ANDREW HUNTER.

THE London International Exhibition of flour mill machinery in May last was considered a decided success.

At the recent Milling Exhibition at Islington the following paper was presented:

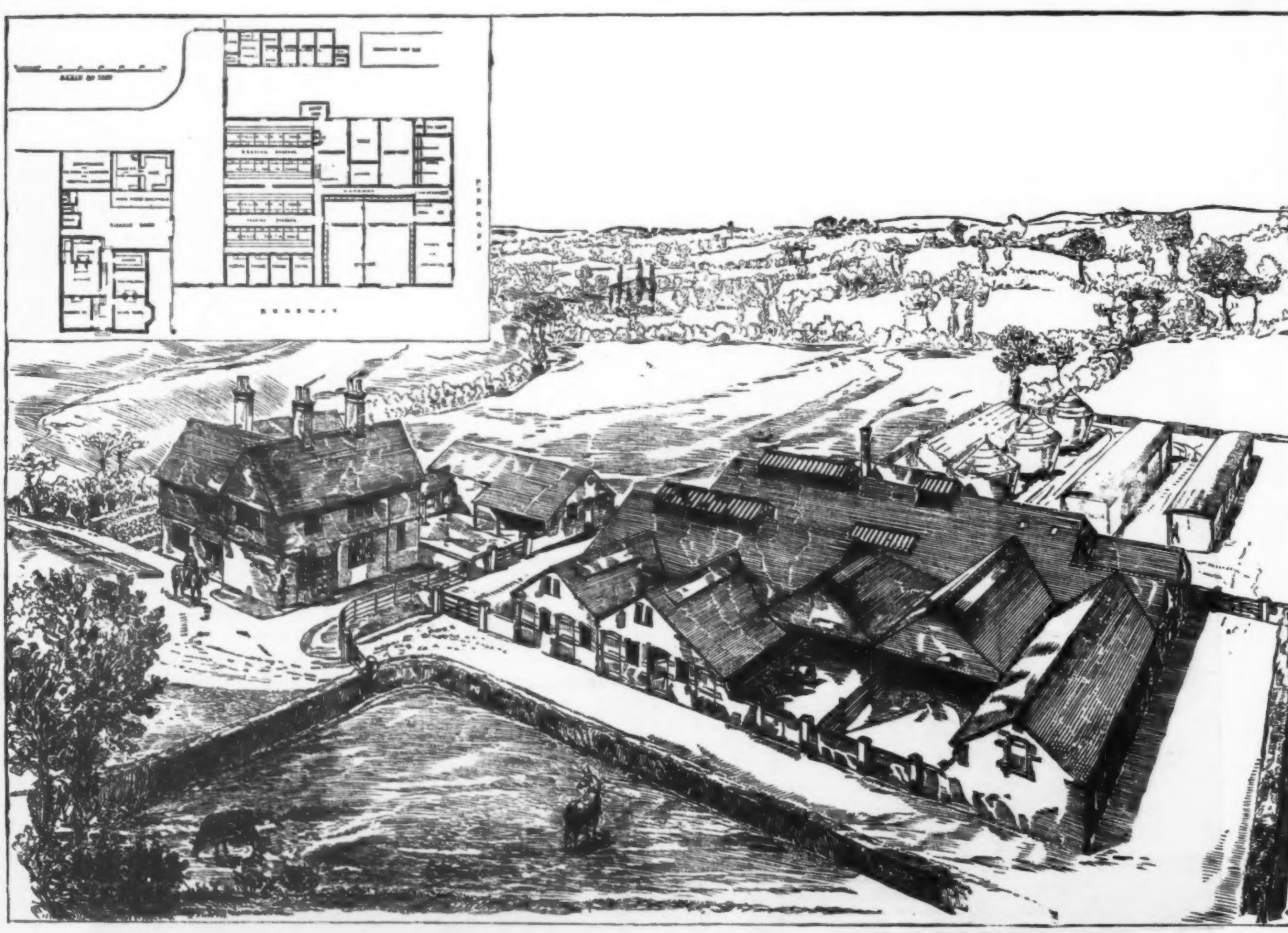
To describe minutely the various changes made in American milling, since the year 1870 until the present time, would require a large volume. There is no acknowledged system as yet that is adopted as a standard. Our leading millers have spent fortunes experimenting on new process milling. For in order to change a mill from the old system to the new process, it was advocated by milling experts to first reduce the speed of the burrs from 200 revolutions to 120 per minute for a four-foot stone; next to reduce the face of the burrs to three-fourths furrow and one-fourth land, and next to reduce the feed from about 18 bushels to six or eight.

The introduction of purifiers into America, by the late N. C. Lacroix, a French millwright and draughtsman, solved the problem how to dispose of the coarse material called sharps or middlings, which, when purified and ground, made a better flour than from the first grinding. The great revolution made in milling is due to the use of middlings purifiers. It prompted millers to make as many middlings as possible. What would high grinding avail us if we could not purify the middlings? It is not my intention to enter into the theoretical details of American milling, but to give a sketch of the best and latest system, and one which British and Irish millers can adopt without incurring the enormous expense of "gutting" and rebuilding their mills.

What is called new process or high grinding is being abolished by our best millers in Minneapolis, Milwaukee, and other milling centers, and gradual reduction substituted. I do not know of a mill in America that is now using a patent dress with three-fourths furrow to one-fourth land; all that put it in were compelled to take it out and use an equalized dress. There are a great many millers who grind to suit their purifiers, because they cannot handle soft or uneven middlings; that is the fault of the purifier, not of medium grinding.

When new process or patent flour is sold for exorbitant prices, then millers could afford to grind very high, and take about six bushels of wheat to make a barrel of flour. They could afford to sell their first flour for a low price and make money. But now, since the entire system of milling in America has been changed, and medium grinding or gradual reduction adopted, and a more perfect system of purification established, it has compelled those who took six bushels of wheat to make a barrel of flour to mill more economically.

I will here give some details of the working of the oldest mill in St. Louis, built over forty years ago. The details can be carried out by any millers in the old country without gutting or rebuilding their entire mill. The mill I refer to



B. D. F. A. FIRST PRIZE MEDAL DESIGN FOR A HOMESTEAD FOR 50 COWS.—RICHARD WAITE, ARCHITECT.

is owned by the Union Steam Mills Company, William H. Maurice, president, and H. Bycroft, an Englishman, head miller. They have four run of stone 5 feet in diameter on wheat, one 3 foot stone on their middlings proper, and one 3 foot stone on fine middlings—they have a 30 inch stone on tailings, and one set of rolls for crushing the germ middlings, with the necessary cleaning machinery. They make with four-run, on winter wheat, 400 barrels of choice flour per day of 24 hours. They make 83 per cent. of Callalily, which has an enviable reputation through the Eastern and Southern States. It is doubtful if any of their flour has ever been shipped there, because they find a ready market for all they can make at home. Their Callalily brand of flour sold last season for $6.50 to $6.85 per barrel. They make or draw off 10 per cent. of patent flour, which sells for $7.50 to $8.25 per barrel by the car load, and 7 per cent. of double X, which sells for $4.50 per barrel. They grind over 18 bushels of wheat on each run of stone. They make a barrel of flour out of less than 4½ bushels of wheat, and manufacture no flour that can be termed low grade. Their system of bolting is good although not perfect. They have not room to put in a perfect system of bolting.

I will now describe our best American system of rebolting flour, selected from our most successful and best paying mills. The numbers of silk given here are intended for medium grinding on American winter wheat, describing six reels in a chest of 20 feet long, and 30 inches in diameter.

First reel is for scalping the bran, clothed with 10 feet of No. 1, and 10 feet of No. 0. The bran that passes over the tail of the reel is run to a bran duster or bran machine. The meal from the first reel is run to the second, clothed with No. 6 silk the entire length. What passes over the tail runs to a purifier. The product, or what passes through No. 2 reel, send to No. 3, clothed with 8 feet 6 inches No. 12 silk, and 8 feet 6 inches No. 13 silk, and 3 feet of No. 5 silk. The flour that is clear at the head draw off to the packer, the residue send to No. 4 reel, clothed with 8 feet 6 inches of No. 14 silk, and 3 feet of No. 6; draw from the head what is clear, and send the residue to No. 5 reel, clothed with 8 feet 6 inches of No. 14 silk, and 8 feet 9 inches of No. 15, and 3 feet No. 7 silk. Draw from the head and send to the packer. The residue send to the No. 6 reel, clothed with No. 16 silk. Return what passes through No. 6 reel to the reel that passes over the tail, and send to the purifier. If the tailings from reels Nos. 3, 4, and 5 contain middlings, send them to No. 6 reel to be dusted.

By adding two more reels it will largely increase the capacity of the chest.

The next thing is how to arrange a chest for bolting patent flour, using three reels in a chest. Run the ground middlings to the first reel, clothed with 8 feet 6 inches No. 12 silk, and 8 feet 6 inches No. 13 silk, and 3 feet of No. 7 silk. What is clean either run off to the packer for patent, or into a conveyor for mixing with the first flour.

The residue run to the second reel, clothed with 8 feet 6 inches No. 13 silk, and 8 feet 6 inches with No. 14 silk, and 3 feet of No. 8, send what is clear to the first reel, the residue send to the third reel, clothed with 10 feet of No. 15 silk, and 10 feet of No. 16 silk. Return what passes through the third reel to the chop or meal; what passes over the tail send to the purifier clothed with fine cloth for handling second middlings. Reels are made in America from 14 feet to 20 feet long, and 30 inches in diameter. They make about 30 revolutions per minute.

I will now describe the Union Steam Mills Company's past and present system of purifying. They are using seven of the Hunter purifiers, and operated when they were first put in the mill, the same as is advocated by suction machines. They divided their middlings on the two machines, and drew off what was considered good enough for the head of the first two, and ran remainder to the other two, and drew off from them and finished on the tailings machine. The fine was handled in the same manner—drawing off a part from the head of the first and finished on the second machine. It will be seen that middlings were drawn off from the three first machines, receiving only a single purification, and only a small portion received the second.

Their present system of purifying is as follows: They make over 20 per cent. of middlings, or upwards of 80 barrels per day. They run all the middlings on the first purifier; what tails over is very poor, the whole product from the first machine is run to the second, and as before, the whole product of the second is run to the third, and the product of the third is run to the fourth. From the fourth purifier, the first part of the middlings are drawn off to the stone, near the tail end of the fourth purifier, and all the tailings from the four machines are run to the fifth, or tailings machine. From the head of the fifth, the middlings are returned back to the first machine. The coarse and germy part from the fifth is sent to the rolls to be crushed not into flour, but to free the middlings from the germ; run what comes from the rolls to a separating reel, clothed with Nos. 10, 4, 2, and 0 silks. What passes through No. 10 cloth, send to the chops; what passes through the coarser cloth send back to No. 1 purifier. Consequently all the middlings that run to the stone have had more than four purifications. I will now describe the purifiers for handling the second middlings and returns from the bolts if desired.

The sixth machine for fine middlings is clothed with fine cloth; all the middlings are run on to it, the product from the sixth is run on to the seventh machine and repurified; from the seventh purifier, the fine middlings stone is supplied, a portion that goes through the coarse cloth of No. 7, and the tailings from 6 and 7 are run to the tailing stone, from the tailings stone the 7 per cent. of double X is made. It is impossible to make second middlings by adopting the above system.

If the Union Steam Mills Company had adopted the new process or high grinding, and had reduced their capacity from 400 barrels per day to 150, it is doubtful if they could pay the expenses of running their mill. I think there is not another mill in America that realizes more from a bushel of wheat. I could refer to other mills that have adopted my system and my machines which are doing equally well; for instance, the Rolla Steam Mills Company, of Rolla, Mo.; they ran their mill for one year, and did not make a barrel of low grade, their flour graded as extra fancy, and sold for 50 cts. per barrel more than any straight flour made in the State of Missouri. I could refer to others, but time and space will not permit.

The practical working of the Union Steam Mills upsets the theory of new process milling, also of slow grinding in Great Britain. In order to grind fast the stone must travel 2,000 feet per minute at the periphery. What is it causes the wheat to travel from the eye of the stones to the periphery? Centrifugal force. Is not the meal kept as long between the stone with the runner making 120 revolutions per minute and grinding 8 bushels per hour, as with a stone making 165 revolutions and grinding 15 bushels? A stone running at 165 will make whiter flour than can be made with a stone running 120. I may refer to a mill I visited the other day; they had 5 run of 4 foot burrs on wheat, 2 on middlings, and 2 run of 3 feet diameter on tailings, and 5 set of rolls for crushing the coarse middlings and cleaning the bran. In 24 hours they made of choice flour 316 barrels, and 169 barrels of patent and 35 barrels of fine, making 520 barrels.

It would not pay to change that mill to a new process or gradual reduction. When they first started the mill they made about 250 barrels under the new process, and their flour was not so good as they make now; the extra expense of making 250 barrels per day was only the coal and a little extra labor. It costs about 30 cents to manufacture a barrel of flour, so that the extra 250 barrels would make a net profit of about $65 per day over slow grinding. I am not surprised that British and Irish millers distrust Americans, who come here to introduce or advocate new systems of milling. What has been your past experience? Systems have and are being introduced here which have been discarded as impracticable and some of them worthless. Have not millers on this side paid dearly for processes guaranteed to enrich every miller in Great Britain? Have not and are not Americans making themselves rich out of their discarded American processes? What evidence have you of the practical working of a system when you examine the work of a mill built expressly to exhibit the work of particular machines? In order to do the same kind of work can you afford to have a stone dresser work a month on the face of a pair of stones to get them in perfect truth?

I could have brought middlings with me from the United States, ground and prepared so that my purifier would work to the best advantage, or I could have had them made for me here; but would it be any evidence that my purifier would work satisfactorily on your middlings? I would suggest that millers should test the different purifiers on their own middlings during the Exhibition, and thus prove for themselves which machines are the best.

In speaking of the latest modes of milling, I would refer to the gradual reduction system, which in my opinion is the true system. There are two systems that are popular—both have ardent supporters—I mean the roller and Jonathan mills; both use from 5 to 7 reductions; they claim in the first and second breaks to free the impurities held in the crease of the berry, where no brush nor scourer can reach, also to disintegrate the chit or germ, which is separated by passing the first and second breaks over a wire screen or bolt.

We find the flour made from the first and second breaks is dark and full of impurites, which cannot be cleared through a No. 16 silk. Tests have been made in the same mill, using the stone and rolls for gradual reduction, on the same kind of wheat; the straight flour from the rolls was white, while the straight flour from the stones was dark, with a reddish cast. When the stone is raised sufficiently to merely break the wheat, it pulverizes the bran, which enters into the composition of the flour and cannot be separated except by a current of air.

If I were building a new mill, I would adopt the gradual reduction system by using the "Jonathan mills" or the rolls for making the middlings, and the burrs for converting them into flour. Nearly all the new American mills that are being built have adopted the gradual reduction system, and a number of mills that had adopted the new process and could not make it pay are changing their mills to the gradual reduction. What I wish to be understood by new-process milling is extremely high and slow grinding, making about 50 per cent. of middlings, about 15 per cent. of low grade, and 35 per cent. of an impure flour. I do not know of a mill in America that has not adopted a new process. And why? Because their present milling differs from the old.

In presenting my views on milling I do not offer for sale any system, but tender my plan to millers gratuitously. That plan of milling can be vouched for by numerous millers who are successful in making the greatest quantity of high-grade flour from a given quantity of wheat. In making purifiers I have carried out the principle farther than any other person, not stopping with the perfect purification of middlings only, but have built a machine which purifies flour successfully. I offer the above remarks and suggestions without prejudice of nationality, being now an American citizen, but formerly a British subject.

SURVEYING OF MINING CLAIMS IN COLORADO.

By RICHARD A. PARKER, C.E.

As the system of public land surveys is well understood by those engaged in the engineering profession it would be needless in a sketch of this nature to dwell upon it at any length, and for the purposes of this article it will be found sufficient to accept the divisions as we find them, in ranges, townships, and sections.

In the main it will be found that there is no difference in the pre-emption of agricultural or mineral lands, as both are described as forming a certain portion of whatever section, township, or range they may be located in; in the case of pre-empted timber or agricultural lands, the description is complete when the direct subdivision of a section is given, as, for example, in Fig. 1, the shaded area would be described

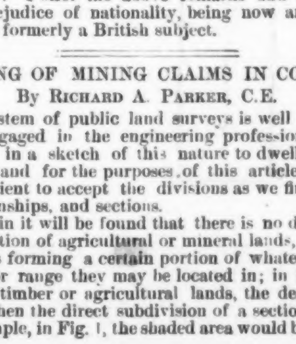


Fig. 1.

as the south half of the southeast quarter, of the northwest quarter of Section ——, Township ——, North (or South) Range ——, East (or West) of ——, Principal Meridian.

In mining districts where aliquot portions of a section are not pre-empted, but claims, consisting generally of rectangles, one hundred and fifty or three hundred feet in width, by fifteen hundred feet in length, a corner of the claim is connected by survey with a corner of the section, and it is thus definitely located.

It is the work of the United States Deputy Mineral Surveyor to survey and locate claims in reference to section corners. In case sectionizing had not progressed to the locality wherein a claim has been established, it is tied to a "locating monument," a description of which will be given later on.

The survey for a mining claim consists of two parts—the survey for location, and the survey for patent.

Before a *valid* location can be made, there are a few points it would be well for the engineer to note in his field book, not that they would in any way affect him or his work, but that they form the basis of the majority of lawsuits, and the benefit of a note made upon the ground, and at the time of survey, would be invaluable; they are: whether, first, the discovery shaft is ten feet deep at its *lowest surface* point; second, that there is a true vein exposed, though not necessarily showing mineral; and third, that he has been called upon to survey the claim within ninety days from the date of the discovery of the lode or vein, as shown by the discovery or location stake.

Lodes are discovered in all sorts of ways, some stumbled on, some showing clean mineral in place, and others legitimately prospected for; the latter requiring knowledge, energy, and pertinacity. The prospector, armed with a few days' rations, pan, coffee pot, pick and shovel, a few gads, hammers, etc., starts for some district and commences the ascent of a mountain he may favor; while so doing a close watch is kept for indications or "float-ore," a decomposed ferruginous quartz that has probably become detached from the vein-filling and rolled down the mountain side. This float is the prospector's polar star. Still ascending until all trace of it has disappeared, he feels that he has then passed above the apex of the vein he is in search of, and descends until it is again encountered. Reascending, he continues until the area which probably contains the vein is narrowed down to a few yards. An adit is run in the mountain side, or a shaft sunk, to determine further the exact location of the vein. If one is found, then a location stake is planted by which ownership is claimed and which forms the initial point of the survey. On it is written a notice containing the date of discovery, the name of the lode and its locator, its general direction, and finally the distances to the end lines of the claim. Sixty days subsequent to the date of discovery is given by law, in which the discovery shaft or adit has to be sunk or driven ten feet; and in case no vein matter or wall-rock is exposed, giving evidence of an existing vein at some greater depth, then such shaft must be sunk until the necessary proof is obtained. These sixty days are usually spent in searching for such out-croppings on or near the surface as will most thoroughly establish the line of the lode upon the ground; as it is of the utmost importance that the latter be accurately determined, in order that the apex of the vein may be contained within the side lines for the full length of the claim, as a second location may be made by another prospector upon the extension of the vein discovered, when found outside of the side or end lines of a claim. Before ninety days have elapsed since the discovery of the lode it must be surveyed, and a description of it, with the names of the locators, placed upon record in the county in which the claim was discovered.

Claims are of a uniform length of fifteen hundred feet at present writing, although the widths vary. In five counties, Gilpin, Boulder, Clear Creek, Summit and Park, they are located seventy-five feet on each side of the discovery shaft (supposed to indicate the position of the vein), and in all others one hundred and fifty feet on each side. The discovery shaft must be in the center of the claim in reference to the side-lines, and in no case can the claim be located so that the distance from the discovery to either side line will exceed the limit of width as placed upon it by the customs of that mining district.

We will suppose the necessary work to be done, and the claim is ready for the surveyor. In case the lode is a straight one, a rectangle of the required width is laid out upon the ground, and stakes planted at each corner and at the middle points of the long side lines, each stake being marked with the name of the lode, and "S. E." "S. middle," etc., to indicate its position on the ground with regard to the claim, to enable prospectors who go over the same country to keep outside the lines of this location. Mountain bearings are to be given from at least two corners or points, and for *this* work an ordinary compass will suffice, though for many reasons it is best to use a transit, and obtain true courses.

If, however, a bend occurs in the outcrop, besides planting stakes at the corners and middle points of the side lines, stakes are to be driven at *each* bend in the survey; thus, in the case of a single bend there would be eight stakes required to properly mark the claim on the ground.

The end-lines 1—6, and 3—4 or 3—4′, as shown in Fig. 2, must in all cases be parallel, and should a bend occur in the lode, the length of one of the end-lines 3—4 must be calculated in order that the claim have a uniform width. To illustrate this and the method generally adopted for obtaining the lengths of the side-lines, let us take the case of a single bend in the claim as shown in the same figure. Here we have given the course A B say N 30° E, eight hundred feet, and B C, N 75° E seven hundred feet. Denote the complement of the angle A B C by a; from the figure it is evident that the side-lines 1—2 and 5—6 are eight hundred feet, and 2—3 and 4—5 are seven hundred feet, plus or minus an increment, it being different in both cases. To determine this increment, through the angle point B draw perpendiculars to the side-lines, the lines F B G and E B D, then will the angle G B D or E B F be equal to the angle a, and E B 5 or G B 2 be equal to ½ a. We now have the line 1—2 equal to A B minus G 2, and 5—6 equal to A B plus G 2 or F 5. But G 2 or F 5 is equal to one-half the claim-width multiplied by the tan. ½ a or

$$\left.\begin{matrix}1—2\\5—6\end{matrix}\right\} = 800 \mp \tfrac{1}{2}\ \text{W tan. } \tfrac{1}{2}\ \text{a}$$

and similarly 2—3 and 4—5 are equal to

$$\text{B B} + \text{H D} - \text{D 2 and B C} - \text{H D} + \text{D.}$$

$$\text{Or, } 700 + \tfrac{1}{2}\ \text{W tan., a} - \tfrac{1}{2}\ \text{W tan., } \tfrac{1}{2}\ \text{a, and}$$

$$700 - \tfrac{1}{2}\ \text{W tan., a} + \tfrac{1}{2}\ \text{W tan., } \tfrac{1}{2}\ \text{a, or}$$

$$\text{L}' = \text{L} \pm \tfrac{1}{2}\ \text{W (tan. a} \mp \text{, tan. } \tfrac{1}{2}\ \text{a) in which}$$

L′ is equal to the length of the side-lines.
L " " " " center "
W " " width of claim.
a " " complement of angle between the center lines.

Should a number of bends occur in the claim, it is readily seen that the solution of side-lines is entirely similar, and it would be needless to carry the illustration further.

The end-line 3 — 4 is equal to $\dfrac{\text{W}}{\text{sin a}}$

If any two alternate courses are parallel then the side

lines of the connecting course are of the same length as the course. The stakes for location work are not generally substantial, being posts two or three inches in diameter and of about as many feet in length, and are not intended for permanent use.

When work sufficient to fulfill the requirements of the aw ($500) has been done, and the property would seem to justify the additional expense, a patent is applied for to obtain a Government title to the land.

This is done by the owners or their representatives, sending a certified copy of the original location as found in the county records, twenty-five dollars and a letter to the Surveyor-General of the State, requesting that an order may be issued to some deputy surveyor to survey the claim. This fee is to pay for the office work necessary for checking the clerical work of the deputy, furnishing blanks, copies of the field notes of the claim surveyed, etc., etc.

Upon receipt of the order to make the survey, the deputy notes the number given to it by the Surveyor-General, and proceeds to make the survey, the claim being thereafter designated by its number. Should additional land be required either for milling or timber purposes, it may be pre-empted with the lode, and all work done upon the latter will be in effect as though done upon the "mill-site," as it is technically called.

In this case a number such as 967 A would designate the lode, and 967 B the mill-site, which must in every case be tied together, as often the lode will be found near the summit of a mountain, and the mill site in the valley half a mile or more distant. The law does not regulate the shape of a mill-site, and its only restriction is that it shall not exceed five acres in area, its survey is in every respect entirely similar to that of a lode-survey as herein described.

The variation of the magnetic needle being so great, ranging from 14° 30′ E to 16° E, and its liability to error

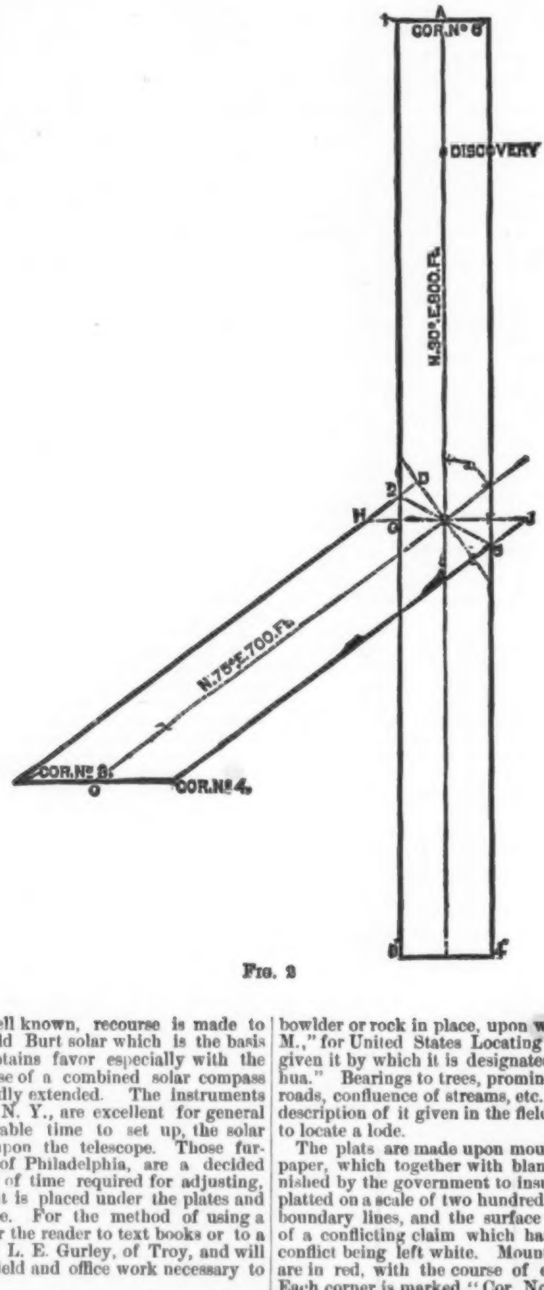


FIG. 3

from local attraction so well known, recourse is made to the solar compass. The old Burt solar which is the basis of every modern one, obtains favor especially with the older surveyors, but the use of a combined solar compass and transit is being rapidly extended. The instruments made by Gurley, of Troy, N. Y., are excellent for general use, but require considerable time to set up, the solar attachment being placed upon the telescope. Those furnished by Young & Son, of Philadelphia, are a decided improvement in the matter of time required for adjusting, and in them the attachment is placed under the plates and removed when not in use. For the method of using a solar transit we would refer the reader to text books or to a handbook issued by W. & L. E. Gurley, of Troy, and will merely give the outline of field and office work necessary to the procuring of a patent.

The fifty foot chain is the principal instrument used for measuring, though there are many places where its use is impossible, and the telemeter takes its place.

The length of of the side-lines (in case of a bend) having been computed, a meridian is established by solar observation, and the courses and distances are run off on the center line, until an angle point, B, Fig. 3, is reached; here the instrument is reset, and the line in which the corners lie (2—5) determined, and the corners located at the end of these lines. Corners are preferably either trees, bowlders or rock in place, and in case they are not found at the exact point, then stone or wooden posts are to be used. If a stone is used, its dimensions must not be less than 4″ × 4″ × 2′, sunk in the ground one foot and protected by a mound of stones; if of wood, then its minimum dimensions are 4″ × 4″ × 4′, sunk *two* feet in the ground and similarly protected by stones; they should be permanently marked with the number of survey and the corner of claim. A square nail-pointed chisel is used for stones, and a timber scribe for wooden posts. From *each* corner a bearing is taken to the nearest natural object, such as stumps, trees, boulders, rocks in place, or any object likely to give permanancy to the corner, and serve to fully locate and identify it. If a tree has been used it should be blazed and marked B. T. (bearing tree) together with the number of survey, and if a stone pointer, an X, with the survey number chiseled on it, will suffice.

If mountain or other bearings were given in the original location certificate, they should be verified by solar observation at the respective points from which they were taken. Should it appear that the bearings or courses do not agree after making due allowance for the variation of the needle at that point, then a new certificate of location must be made out, placed upon record, and used as a guide instead of the original one.

Close attention must be given to see that the solar survey covers every point embodied in the original certificate, otherwise the work will have to be repeated. It is usual to make in the field-book a diagram of the lode with all details as called for, and verify each point as the survey progresses.

While in the field all improvements, such as shafts, tunnels, drifts, houses, etc., placed upon the claim by the applicant for a patent, are noted with their approximate value and their position in reference to some corner of the claim ascertained. Crossings of roads, fences and creeks are noted, and connecting lines run to the section corner and all adjacent patented surveys, as they must be shown upon the plat and field notes sent to the Surveyor-General. Should, however, there be no section corner within two miles of the claim, then the deputy is directed to establish a "locating monument," which consists of a bar of copper or iron, one inch in diameter, inserted in some prominent bowlder or rock in place, upon which is chiseled, "U. S. L. M.," for United States Locating Monument, and a name is given it by which it is designated, as "U. S. L. M. Chihuahua." Bearings to trees, prominent peaks, the junction of roads, confluence of streams, etc., are to be given, and a full description of it given in the field notes each time it is used to locate a lode.

The plats are made upon mounted sheets of Whatman's paper, which together with blank field note paper is furnished by the government to insure uniformity. Lodes are platted on a scale of two hundred feet to one inch, with black boundary lines, and the surface colored except in the case of a conflicting claim which has a prior title, the area in conflict being left white. Mountain and all other bearings are in red, with the course of each one plainly lettered. Each corner is marked "Cor. No. 1, Cor. No. 2," etc. The connection from Cor. No. 1 to the section corner is shown, as is also the section or quarter-section lines in which the claim is placed.

"If in running the exterior boundaries of a claim, it is found that two surveys conflict, the plats and field notes should show the extent of the conflict, giving the area embraced in both surveys, and also the distance from the established corners at which the exterior boundaries of the respective surveys intersect each other." In notes give area as follows:

Total area..............	5·16
Less area in conflict with surveys Nos. 967 and 1151.....	2·00
Leaving a net area	3·16

On the plat the net area only is given. The following will give the general form of field notes at present in use:

Field notes of the survey of the claim of G. G. Jones, on the Porter Lode and Mill Site, situated in Griffith Mining District, Clear Creek County, State of Colorado.

Survey begun June 1, 1880
Survey ended June 3, 1880.

Feet.	
	Beginning at the S. E. cor. Sec. 27, T. 3 S. R. 76 W.; thence N. 27° 15′ 39″ W.
	Var. 15° 30′ E.
7462·84	To Cor. No. 1 beginning, a granite post 26″ × 7″ × 12″ in the ground one foot, and protected by a mound of stones, and is marked 1—973 A; whence cor. No. 1, sur. No. 963 B, Porter Mill site, G. G. Jones, applicant, bears S. 27° 16′ 26″ W., 10,841·2 ft. distant. Republican Mt. bears N. 10° 12′ E., and Democrat Mt. bears N. 16° 14′ W.; cor. No. 3, sur. No. 840; Pluto Lode, James Gorman, applicant, bears S. 0° 10′ W. 402 ft. A × 963 A, cut on N. face of bowlder bears S. 23° 15′ W. 21 ft.
	Thence S. 23° 47′ W.
903·7	To east line of sur. No. 465, Bullion Lode, Colorado Mining Company, applicants, and from cor. No. 5 of sur. No. 465 to the same point of intersection, S. 34° 21′ E., 87·2 ft.
1,069·4	To west line of sur. No. 465, and from cor. No. 2 of same survey, S. 34° 21′ E., 133·4 ft. to the point of intersection.
1,243	To road to Georgetown running N. 85° W.
1,500	To Cor. No. 2, a pine post four inches by four inches by four feet, marked 2—963 A, in ground two feet, and in mound of stones, whence a spruce tree 16 inches diameter; blazed and marked B. T. —963 A, bears N. 63° E. 20 ft. Squaw Mt. bears S. 83° E., and Little Chief Mt. S. 74° 30′ E.
	Thence N. 66° 13′ W.
150	To cor. No. 3, a spruce post, etc., etc.

The plat and field notes being finished and sworn to by the deputy and those that assisted in marking corners, chaining, etc., they are then sent to the Surveyor-General's office for approval. If any clerical error has occurred, or if it be found by calculation that the connecting lines through the several intersecting lodes to the section corner disagree, then the plat and field notes are returned with a marginal note, as "*out thro' 465 with sec. cor.*," and the error must be discovered and corrected. If the work be right, then it is platted upon the general map of that section of the country, and two approved copies sent to the deputy, with one copy of the field notes; another set of both is sent to the U. S. Land office, for government use. The patent for the land is now applied for, and the furthering of it properly belongs to a lawyer, as may readily be imagined, by glancing over the list of "first" or preliminary papers.

A complete abstract of title.

A certified copy of the pre-emption of lode and mill site.

Proof by affidavit of non-mineral character of the mill site.

Affidavit of work done on the lode.

Copy of articles of incorporation of the company, if land is pre-empted by an organization.

Certificate of agency.

Copy of field notes with affidavit of persons assisting on the survey.

Two copies of the plat (as approved).

An approved copy of same furnished by the Surveyor-General.

Proof of citizenship and peaceable possession of claim.

Proof of posting a notice that a patent has been applied for.

But as this paper was intended to give an outline of the method and requirements of claim surveying, it would be tedious to attempt to follow the papers through their official career, and it will suffice to say that it generally consumes a year before the government titles are perfected.

The work of claim surveying is not difficult, requiring care alone, and to the young engineer there are few fields that offer inducements at all comparable with Colorado, and especially the lately developed districts of San Juan and Gunnison.

The value of engineers' work as *surveyors only* is appended below. General underground or surface work, $10 per day. Locations $6 to $10 each, inclusive of expenses, such as horse-hire and placing the location on record, which costs $1.50. Patents cost all the way from $150 to $225, the official fees of which range from $95 to $140, and are of course included in the above estimate.—*School of Mines Quarterly.*

SUBTERRANEAN TELEGRAPH CABLES.

THE German Postmaster-General has been busy laying down subterranean cables in order to secure telegraphic communication against destruction of the lines by atmospheric influences, such as hurricanes and snowstorms, and he has completed 4,000 kilometers of underground lines. They are as follows: From Berlin *via* Halle, Cassel, Frankfort-on-Main to Mayence; from Halle to Leipsic; from Berlin *via* Magdeburg, Brunswick, Hanover, Minden, Munster, Wesel, Düsseldorf to Cologne; from Berlin to Hamburg and Kiel; from Cologne to Elberfeld and Barmen; from Frankfort-on-Main *via* Darmstadt; Mannheim, Carlsruhe, Rastott, Kehl to Strasburg; from Hamburg to Cuxhaven, and *via* Bremen to Emden, with branch lines to Wilhelmshaven and Bremerhaven; from Cologne to Coblentz, Treves, and Metz; from Metz to Strasburg, and from Berlin to Dresden. There are still under construction the lines from Berlin to Frankfort-on-Oder, Breslau, and Oderberg on the Austrian frontier; from Berlin to Stettin; from Berlin to Muncheberg, and from Berlin to Marienburg, Königsberg and Eidkuhnen on the Russian frontier; they are likely to be finished during this year. The cables, which are manufactured by the celebrated firm of Guilleaume & Felten, of Cologne and Mulheim-on-Rhine, contain from four to seven insulated copper strands in a core of gutta-percha, which is sheathed with a covering of tarred Russian hemp and with galvanized iron wire, and a covering of asphaltum. The conducting strands are made of seven thin copper wires each, which are wound and twisted in one solid rope of copper; by this arrangement the danger of an unexpected rupture at a weak place is quite avoided; even if a couple of the wires were broken, the conducting strand would still be quite serviceable, while a single wire as a conductor would become useless by fracture. When completed, these underground lines will contain not less than 30,000 kilometers (18,000 miles) of serviceable conductors. It appears that

France has also commenced to revert to underground telegraph lines, and if they had been in use in this country much inconvenience would have been avoided during last winter's extremely heavy and destructive storms.

NEW TELEPHONES.

IT is somewhat remarkable that, in spite of the enormous number of experiments which have been carried out, surprisingly little progress has been made toward obtaining a perfect telephone. Progress *has* been made, undoubtedly, but it is out of all proportion to the amount of energy which has been expended on the subject. Theoretically, a telephone to speak out as loud as desired is as apparently possible as the possibility of making an extremely weak telegraphic current, relay an equally strong current with certainty. The weak received telephonic currents should apparently be able to unlock corresponding currents of a much greater intensity, or the action of the transmitter should be able to control currents sufficiently powerful to produce a giant's voice, yet actually nothing like this result has been accomplished. The so-called loud-speaking telephones indeed approach the threshold of the theoretical possibility, but they seem unable to go further.

Loud speaking, it is true, is not required, or indeed desirable for general use, but clearness of utterance is, and if the general problem be solved, it is always possible to tone down and shape to any particular requirement, just as a Koh-i-noor can be shaped down from a large shapeless mass, though we cannot produce it from a less bulk.

We continually hear of new forms of telephones which are stated to give wonderful results, but we must confess that our experience of such inventions has been anything but hopeful, as they almost invariably fail to give the glowing results which their inventors claim for them, except under extraordinary conditions.

It is rarely that we hear of distinct departures from the old lines in inventions; inventors are disinclined to attempt to obtain effects from unpromising materials, and a few unsuccessful trials usually drive them back into the old groove, so that they content themselves with improving what they know will work rather than go groping in the dark after what may, after all, prove to be an idle dream.

Although Dr. Herz's telephone, which was described in our last issue, was foreshadowed to some extent, yet the results obtained are somewhat surprising, and are likely to prove of considerable value, inasmuch as they prove the practicability of obtaining telephonic communication by other means than those which are at present considered to be the exclusive property of one or two individuals. The statement that an efficient microphonic transmitter can be formed from other materials than carbon is important if the employment of the latter material is covered by a patent, which point, we understand, is to be contested. The use of a receiver which is not magnetic is also an important feature, as we believe such a receiver is not the subject of an existing patent, at least in this country. If, therefore, Dr. Herz's discoveries promise as well as they appear to do, they may inaugurate a new era in telephony.

It is claimed by the inventor that his system avoids that bugbear of telephony, viz., "induction;" this we are inclined to think is only partially the case, and the theory that it should effect the cure because there is no circuit, is entirely fallacious and contrary to theory.

The effect of one current flowing in the neighborhood of another is to disturb the equilibrium at the moment when the current flows or ceases to flow. If the wire in which the equilibrium has a tendency to be upset be disconnected at both ends, then the conditions for a variation cease to exist; but insert a condenser at one or both ends, and then a disturbance outside the wire will tend to cause a current to flow in the wire, which current will flow into the condenser until the potential in the latter reaches a certain point dependent upon the strength of the inducing current and the capacity of the condenser; increase the latter to infinity, and we shall then obtain an induced current as strong as we should get if the wire were earthed at both ends, although in the one case there is disconnection or no circuit, and in the other a complete loop. *Steady* earth currents, it is true, are cut off, but if there is a variation in these they will, in virtue of their change, produce an induced effect, exactly as will the telephonic currents.—*Telegraphic Journal*

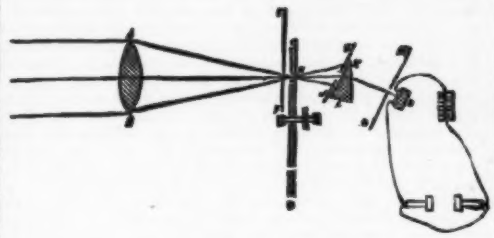
THE HERZ TELEPHONE.

THE new telephone of Dr. Cornelius Herz, which has given such good results in long distance telephoning over the lines from Paris to Tours, Poitiers, Bordeaux, etc., consists of a novel microphone transmitter and a speaking condenser. The transmitter is composed of twelve microphonic contacts, each formed by two disks of iron pyrites or other metallic sulphides pressed together by a spring and suspended in pairs from a vibrating diaphragm of wood. A battery of twelve cells is connected between the "earth" and line in such a manner that each cell is in circuit with a microphonic contact, a plan which reduces the combined resistance of the contacts. The tinfoil receiving condenser is made after a hand looking-glass pattern, so that it can be held close to the ear, and is connected between the line and earth at the receiving station. Besides giving distinct articulation it has the advantage of interrupting the line circuit, and thus cutting off to a considerable extent the influence of extraneous currents on the line. Dr. Herz also employs a Graham Bell telephone as receiver; and in this case he cuts off the extraneous currents by interposing a condenser between the line and telephone, as well as a "comb" lightning protector (that is, two opposed brushes of metal points) between the telephone and earth.

MEASURING THE INDEX OF REFRACTION OF EBONITE.*

PROF. BELL found that when an intermittent beam of light fell on a sensitive selenium cell the sound produced in a telephone (which with a battery was attached to the selenium) was not entirely destroyed by interposing a thin sheet of ebonite in the path of the intermittent rays of light, or, in other words, that ebonite was slightly transparent for invisible rays tha affected selenium. It occurred to us some months ago that if such invisible rays were at all of the nature of light, they probably suffered retardation in passing through the ebonite, or that refraction would take place if the sheet of ebonite were replaced by an ebonite prism or lens, a result we have been able experimentally to confirm, and at the same time to measure the index of refraction.

A B is a glass lens concentrating a parallel beam coming from a lime-light on to one hole, H, in a rapidly revolving brass disk, C D. This disk we have constructed many times as thick as the one employed by Prof. Bell, and have thus



succeeded in eliminating all the sound produced by the siren action of the disk, so disturbing in delicate experiments. E F is a stationary zinc screen with a hole in it smaller than the holes in the rotating disk.

1. We first tried to focus these intermittent rays on a selenium cell by means of an *ebonite* lens, and so determine the focal length of the lens; but as our lens was then not mounted on an optical bench, so as to be moved parallel to itself, or rotated through known angles, and as the rays were invisible, so that our eyes could not of course guide us as to the proper position in which to put the lens, we failed to succeed in this very delicate experiment, which, however, our subsequent experiments, now to be described, show must ultimately succeed with the lens properly mounted.

2. A small portion of the intermittent light which passed through the hole, H, in the rotatory disk, was allowed to fall on an ebonite prism, K L, by passing through a slit in a zinc screen, G J, the slit being arranged parallel to the edge of the ebonite prism. The prism employed had an angle of 27·5°. M N is another zinc screen with a slit in it also parallel to the edge of the prism, and placed in front of a sensitive selenium cell, S (the cell described by us in the account of our experiments on "Seeing by Electricity"). This screen, M N, was moved parallel to itself, while an experimenter listened with a telephone to each ear, and who was placed in another room, so as not to be influenced by seeing what changes were being made in the position of the screen or in the position of the ebonite prism. The telephones had each a resistance of 74 ohms, and the battery an electromotive force of about 40 volts. No direct light falling on the selenium, the listener at the telephones heard nothing for the majority of positions of the screen, M N, but in one position represented in the figure a faint distant sound was distinctly heard, which was entirely cut off by interposing the hand in front of the selenium, or by moving away the prism.

The invisible rays that affect selenium after passing through ebonite are consequently refracted, and some preliminary experiments, when the ebonite prism was arranged for minimum deviation, gave 1·7 as a first rough approximation for the index of refraction of these rays by ebonite. It is interesting to notice that the square, 2·89, of this index of refraction is between the highest and lowest limits obtained by different experimenters for the specific inductive capacity of ebonite, so far agreeing with Maxwell's electromagnetic theory of light.

We are now having prisms of ebonite and of other opaque substances of different angles mounted on a goniometer stand, to enable us to measure the indices of refraction accurately.

* Note communicated to the Royal Society by Professors Ayrton and Perry.

[FROM THE LONDON TIMES.]

THE STORAGE OF ELECTRICITY.—INTERESTING SCIENTIFIC CORRESPONDENCE.

WE subjoin a series of letters by distinguished men of science in which the value of the new Faure battery is discussed from several different standpoints:

SIR WILLIAM THOMSON'S LETTER CONCERNING ELECTRIC STORAGE.

SIR: The marvelous "box of electricity" described in a letter to you which was published in the *Times* of May 16, has been subjected to a variety of trials and measurements in my laboratory for now three weeks, and I think it may interest your readers to learn that the results show your correspondent to have been by no means too enthusiastic as to its great practical value. I am continuing my experiments to learn the behavior of the Faure battery in varied circumstances, and to do what I can toward finding the best way of arranging it for the different kinds of service to which it is to be applied. At the request of the Conseil d'Administration of the Société de la Force et la Lumière, I have gladly undertaken this work, because the subject is one in which I feel intensely interested, seeing in it a realization of the most ardently and unceasingly felt scientific aspiration of my life—an aspiration which I scarcely dared to expect, or to hope to live to see realized.

The problem of converting energy into a preservable and storable form, and of laying it up in store conveniently for allowing it to be used at any time when wanted, is one of the most interesting and important in the whole range of science. It is solved on a small scale in winding up a watch, in drawing a bow, in compressing air into the receiver of an airgun or of a Whitehead torpedo, in winding up the weights of a clock or other machine driven by weights, and in pumping up water to a height by a windmill (or otherwise, as in Sir William Armstrong's hydraulic accumulator) for the purpose of using it afterward to do work by a waterwheel or water pressure on a piston. It is solved on a large scale by the application of burning fuel to smelt zinc, to be afterward used to give electric light or to drive an electro-magnetic engine by becoming, as it were, unsmelted in a voltaic battery. Ever since Joule, forty years ago, founded the thermodynamic theory of the voltaic battery and the electro-magnetic engine, the idea of applying the engine to work the battery backward and thus restore the chemical energy to the materials so that they may again act voltaically, and again and again, has been familiar in science. But with all ordinary forms of voltaic battery the realization of the idea to any purpose seemed hopelessly distant. By Planté's admirable discovery of the lead and peroxide of lead voltaic battery, alluded to by your correspondent, an important advance toward the desired object was made twenty years ago; and now by M. Faure's improvement practical fruition is attained.

The "million of foot pounds" kept in the box during its seventy-two hours' journey from Paris to Glasgow was no exaggeration. One of the four cells, after being discharged, was recharged again by its own laboratory battery, and then left to itself absolutely undisturbed for ten days. After that it yielded to me two hundred and sixty thousand foot pounds (or a little more than a quarter of a million). This not only confirms M. Reynier's measurements, on the faith of which your correspondent's statement was made; it seems further to show that the waste of the stored energy by time is not great, and that for days or weeks, at all events, it may not be of practical moment. This, however, is a question which can only be answered by careful observations and measurements carried on for a much longer time than I have hitherto had for investigating the Faure battery. I have already ascertained enough regarding its qualities to make it quite certain that it solves the problem of storing electric energy in a manner and on a scale useful for many important practical applications. It has already had in this country one interesting application, of the smallest in respect to dynamical energy used, but not of the smallest in respect to beneficence, of all that may be expected of it. A few days ago my colleague, Prof. George Buchanan, carried away from my laboratory one of the lead cells (weighing about eighteen pounds) in his carriage, and by it ignited the thick platinum wire of a galvanic *ecraseur* and bloodlessly removed a nævoid tumor from the tongue of a young boy in about a minute of time. The operation would have occupied over ten minutes if performed by the ordinary chain *ecraseur*, as it must have been had the Faure cell not been available, because in the circumstances the surgical electrician with his paraphernalia of voltaic battery to be set up beforehand, would not have been practically admissible.

The largest useful application waiting just now for the Faure battery—and it is to be hoped that the very minimum of time will be allowed to pass till the battery is supplied for this application—is to do for the electric light what a water cistern in a house does for an inconstant water supply. A little battery of seven of the boxes described by your correspondent suffices to give the incandescence in Swan or Edison lights to the extent of 100 candles for six hours, without any perceptible diminution of brilliancy. Thus, instead of needing a gas engine or steam engine to be kept at work as long as the light is wanted, with the liability of the light failing at any moment through the slipping of a belt—an accident of too frequent occurrence—or any other breakdown or stoppage of the machinery, and instead of the wasteful inactivity during the hours of day or night when the light is not required, the engine may be kept going all day and stopped at night, or it may be kept going day and night, which will undoubtedly be the most economical plan when the electric light comes into general use. The Faure accumulator, always kept charged from the engine by the house supply wire, with a proper automatic stop to check the supply when the accumulator is full, will be always ready at any hour of the day or night to give whatever light is required. Precisely the same advantages in respect of force will be gained by the accumulator when the electric town supply is, as it surely will be before many years pass, regularly used for turning lathes and other machinery in workshops and sewing machines in private houses.

Another very important application of the accumulator is for the electric lighting of steamships. A dynamo-electric machine of very moderate magnitude of expense, driven by a belt from a drum on the main shaft working through the twenty-four hours, will keep a Faure accumulator full, and thus, notwithstanding irregularities of the speed of the engine at sea or occasional stoppages, the supply of electricity will always be ready to feed Swan or Edison lamps in the engine room and cabins, or arc lights for mast head and red and green side lamps, with more certainty and regularity than have yet been achieved in the gas supply for any house on terra firma.

I must apologize for trespassing so largely on your space. My apology is that the subject is exciting great interest among the public, and that even so slight an installment of information and suggestions as I venture to offer in this letter may be acceptable to some of your readers.

I remain your obedient servant,

WILLIAM THOMSON.

The University, Glasgow, June 6, 1881.

A DAMPER FOR SIR WILLIAM THOMSON'S ENTHUSIASM.

THE London *Times* prints the following letter to the editor of that journal:

SIR: Although agreeing with every word of Sir William Thomson's letter in the *Times* of to-day, and entirely sympathizing with his enthusiasm as regards the marvelous box of electricity, still I feel that it would have been desirable if, in pointing out the importance of this new discovery, Sir William Thomson had guarded against a very probable misconstruction of the purport of his letter.

The means of storing and re-storing mechanical energy form the aspiration, not only of Sir William, but of every educated mechanic. It is, however, a question of degree—of the amount of energy stored as compared with the weight of the reservoir, the standard of comparison being coal and corn. Looked at in this way, one cannot but ask whether, if this form of storage is to be the realization of our aspirations, it is not completely disappointing. Large numbers are apt to create a wrong impression until we inquire what is the unit. Eleven million foot pounds of energy is what is stored in one pound of ordinary coal. So that in this box, weighing seventy-five pounds, there was just as much energy as in one and one-half ounces of coal, which might have been brought from Paris or anywhere else in a waistcoat pocket, or have been sent by letter.

When we come to the question of the actual conveyance of energy for mechanical purposes, this view is of fundamental importance. The weight of the same amount of energy in the new form is eight hundred times greater than the equivalent amount of coal; and, as a matter of economy, supposing that energy in this form might be had at a certain spot and no capital were required for its conversion or storage, and that the energy were directly applicable, it could not be carried ten miles—that is to say, such energy cannot be economically useful ten miles from its source, although coal had to be carried one hundred miles to the spot. This limit, in truth, falls far short of what has been already attained by other means. By wire ropes and by compressed air or steam energy may be economically transmitted from ten to twenty miles. So that if this is the utmost of what is to be done by means of the storage of electricity this discovery adds another door to those which are hopelessly closed against the possibility of finding in Niagara, or other water power, a substitute for our coal, even when the object is motive power, and much more for that purpose for which five-sixths of our coal is used—the production of heat.

It is very important that the people of this country should not shut their eyes to the fact that so far from there being a greater prospect of the solution of the problem than when, about twenty years ago, Professor Jevons raised the alarm, the prospect is now much smaller. In the meantime the capabilities of steel ropes, fluids in pipes, and electricity along conductors, have been not only investigated, but practically tested and found altogether wanting. And now it would seem that the storage of electricity must be added to the list. OSBORNE REYNOLDS.

Owens College, June 9.

ANOTHER LETTER FROM PROFESSOR THOMSON.

SIR: Your leading article in the *Times* of yesterday on the storage of electricity alludes to my having spoken of Niagara as the natural and proper chief motor for the whole of the North American continent. I value the allusion too much to let it pass without pointing out that the credit of originating the idea and teaching how it is to be practically realized by the electric transmission of energy is due to Mr. C. W. Siemens, who spoke first, I believe, on the subject, in his presidential address to the Iron and Steel Institute in March, 1877. I myself spoke on the subject in support of Mr. Siemens' views at the Institution of Civil Engineers a year later. In May, 1879, in answer to questions put to me by the Select Committee of the House of Commons on Electric Lighting, I gave an estimate of the quantity of copper conductor that would be suitable for the economical transmission of power by electricity to any stated distance; and taking Niagara as example, I pointed out that, under practically realizable conditions of intensity, a copper wire of half an inch diameter would suffice to take 26,250 horse power from water wheels driven by the fall, and (losing only 20 per centum on the way) to yield 21,000 horse power at a distance of 300 British statute miles; the prime cost of the copper amounting to £60,000, or less than £3 per horse power actually yielded at the distant station.

I remain, sir, your obedient servant,

WILLIAM THOMSON.

The University, Glasgow, June 9.

PROF. THOMSON REPLIES TO PROF. REYNOLDS.

To the Editor of the London Times:

SIR: If you do me the honor to publish a letter which I wrote to you yesterday regarding the electric transmission of energy, it will be seen that I thoroughly sympathize with Professor Osborne Reynolds in his aspirations for the utilization of Niagara as a motor, but that neither Mr. Siemens nor I agree with him in the conclusion which he asserts in his letter to you, published in the *Times* of to-day, that electricity has been tried and found wanting as a means for attaining such objects. The transmission of power, however, was not the subject of my letter to you published in the *Times* of the 9th instant, and Professor Reynolds' disappointment with M. Faure's practical realization of electric storage, because it does not provide a method of porterage superior to conduction through a wire, is like being disappointed with an invention of improvements in water cans and water reservoirs, because the best that can be done in the way of movable water cans and fixed water reservoirs will never let the water carrier supersede water pipes wherever water pipes can be laid.

The $1\frac{1}{2}$ ounces of coal cited by Professor Osborne Reynolds as containing a million of foot pounds stored in it is no analogy to the Faure accumulator containing the same amount of energy. The accumulator can be recharged with energy when it is exhausted, and the fresh store drawn upon when needed, without losing more than ten or fifteen per centum with arrangements suited for practical purposes. If coal could be unburned—that is to say, if carbon could be extracted from carbonic acid by any economic process of chemical or electric action, as it is in nature by the growth of plants drawing on sunlight for the requisite energy—the result would be analogous to what is done in Faure's accumulator.

I remain your obedient servant,

WILLIAM THOMSON.

The University, Glasgow, June 11.

PROF. AYRTON REPLIES TO PROF. REYNOLDS.

SIR: Prof. Osborne Reynolds' letter in your issue of Saturday, the 11th inst., shows that the first idea that has occurred to him on reading Sir William Thomson's letter on Faure's "electric store" is probably what must have suggested itself to many engineers—namely, that so far from a million foot pounds being a surprisingly large amount of energy to be stored up in a mass of seventy-five pounds, it is really extremely small; and, indeed, while crossing over from Paris at the commencement of last week, I could not help thinking that the passengers were bringing to England literally in the smuts and blacks on their coats far more energy than had ever been imported into this country stored up in Faure's secondary batteries. But although it is perfectly true, as Prof. Reynolds says, that $1\frac{1}{2}$ ounces of coal contain about one million foot pounds of work stored up in it, this is by no means all that has to be taken into account in considering this question; for where is the engine for extracting this million foot pounds of work out of the $1\frac{1}{2}$ ounces of coal? Indeed, as Prof. Reynolds would himself tell us, we cannot get much more than one-tenth of this amount of work out of the $1\frac{1}{2}$ ounces of coal, even in our largest steam engines, which burn many pounds of coal per minute, and in which much heat has been wasted in getting up steam. And if we come to the burning of one single $1\frac{1}{2}$ ounces of coal, I know of no engine that can obtain from this even one thousand foot pounds of work, or one-thousandth of the energy contained in the coal, if no other coal be used in getting up steam or in previously heating the engine.

But if a secondary battery be allowed to drive a magneto-electro motor or a dynamo-electric machine with separate exciter only even for the short time necessary to develop, say, 30 foot pounds of mechanical work, I anticipate this can be done without using up in the whole process more than about 35 foot pounds of the electric energy stored up in the reservoir, since the experiments of Prof. Perry and myself have shown that when the motor is running at high speed with a light load, as much as 93 per centum of the electric energy put into a magneto-electro motor is given out again as mechanical work measured by an absorption dynamometer.

It may be answered, however, that if a small bit of coal, although containing a vast store of energy, is not of much practical use in producing work in consequence of the absence up to the present time of a proper converter of the coal's energy into mechanical work; at any rate, a small galvanic battery (a little Daniell's cell, for example) is not only a vast storehouse of power, but contains a store which we have the means of converting without appreciable loss into electric light or mechanical work. How, then, is a Faure's box a better store of electric energy than a little Daniell's cell? This question has precisely the same answer as, "Why is a pinch of dry gunpowder better than a pinch of wet?" Not because the dry gunpowder has more energy in it than the wet, but because the energy stored up in the dry gunpowder can be all, if we wish, used up quickly, and an explosion produced, whereas that in the wet can only be utilized bit by bit. So seven Faure's boxes will illuminate one hundred Swan lamps for six hours, while seven Daniell's cells, or, indeed, twice that number, although possessing a store of power millions of times as great as that in the Faure's boxes, will not illuminate a single Swan light.

But while fully recognizing the great advance made in the subject by Planté, and the recent improvements introduced by Faure, I do not wish to give the impression that the problem is by any means completely solved, since, if the attempt that Mr. Perry and myself, no doubt like many other electricians, are making to convert at a low temperature the energy in coal into electric energy meets with even a fairly satisfactory solution, then a fragment of coal, or, it may be, a puff of gas rich in carbon or carbonic oxide, will be a practical store of energy of incomparably greater value than any secondary battery.

W. E. AYRTON,

The City and Guilds of London Technical College, Finsbury.

DOMESTIC ELECTRICITY.

DURING the past few years, the application of electricity to certain domestic purposes has become pretty general; but it must be admitted that the application thus far is almost exclusively confined to electric call-bells and electric alarms. There are, however, many other very useful apparatus which could be employed in the household, along with the bells, necessitating no cost to keep them in order and requiring no source of electricity more powerful than do the electric bells themselves. Among these are electric lighters, two types of which are represented in the accompanying cuts taken from *La Nature*. These apparatus offer a simple, elegant, and ingenious solution of a problem which may be formulated thus: To establish an electrical system in such a way that on closing the circuit by a contact on the system, a lamp placed at a distance may be lighted if it is extinguished, or extinguished if already lighted. In the system of M. Maigret, represented in Fig. 1, a spirit or kerosene lamp is placed on a base which contains a horizontal electro-magnet. The armature of the latter carries two long copper rods to which are fixed a small platinum spiral. These rods act at the same time on a small bellows, to which is affixed a tube whose upper extremity is situated near the wick of the lamp, as seen in the figure. On sending a current into the apparatus one of two things occurs, according to circumstances: if the lamp is extinguished, the current traverses at once the electro-magnet and the spiral. The former attracts the armature and brings the incandescent spiral near to the wick, which thereupon bursts into flame. The fact that the bellows is put in action before the spiral approaches the wick offers no inconvenience, since the air is blown against an unlighted wick. When the current ceases to pass, the spiral falls back again to its former position and leaves the lamp lighted. (2.) If the lamp is lighted, the current traverses the electro-magnet, and the bellows acting this time extinguishes the lamp; and, if the contact is not prolonged sufficiently to give the spiral time to relight the wick, the spiral again falls back to its first position as soon as the current ceases to pass, and leaves the lamp extinguished. The form of the apparatus is such that it might easily be placed on a swinging bracket or be suspended by ordinary means in a sleeping apartment or in rooms where light is needed at irregular intervals.

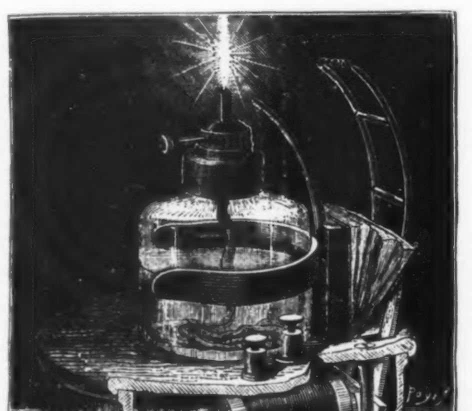


FIG. 1.—MAIGRET'S ELECTRIC LIGHTER.

FIG. 2.—RANQUE'S ELECTRIC LIGHTER.

The apparatus of M. Paul Ranque (Fig. 2) is no less ingenious than the one just described. Instead of a jet of air being employed to extinguish the flame, that end is attained in this lamp by means of an extinguisher, which has the additional advantage that by covering the wick it prevents the evaporation of the fluid which the lamp contains. As in the other apparatus, an electro magnet located in the base of the lamp actuates the incandescent spiral and the extinguisher. Fig. 2 represents the position of the movable parts when the lamp is lighted. On sending the current into the lamp when in this position, a small elastic strip, mounted on the rods supporting the spiral, presses against a hook-shaped strip at the base of the wire carrying the extinguisher, thus tilting the latter and causing it to drop over the wick. The object in giving the strip at the base of the extinguisher-support a hooked shape is to limit the course of the spiral and prevent it from being damaged by striking it against the extinguisher. On causing the current to pass when the lamp is extinguished, the elastic strip passes *over* the hook-shaped strip, raises at the same time both it and the extinguisher, while the platinum spiral having become incandescent, approaches the wick and lights it. Practically, both these forms of apparatus work equally well, and there is perhaps but little choice to be made between them.

PHYSICAL SOCIETY, LONDON, APRIL 9, 1881.

Prof. W. G. ADAMS in the Chair.

DR. J. H. GLADSTONE read a "Note on Thermal Electrolysis," by himself and Mr. Alfred Tribe. The authors found that when sheet silver was plunged into fused silver chloride, or iodide of silver, crystals of silver formed on the sheet. Similarly, copper immersed in fused cuprous chloride, had copper crystals deposited on it; and when zinc was placed in melted zinc chloride, or iron in melted ferrous chloride, these two metals crystallized on the plates. They found this to be due not to a difference in the physical condition of the rolled metals, but to the unequal heating of the different parts of the immersed metals. By the contact theory of voltaism there will be a difference of potential between the metal and the liquid chloride in contact with it, and this difference of potential will vary with temperature. Since all parts of the immersed metal cannot be supposed at the same temperature always, there is the possibility of a current being set up, and consequent electrolysis of the salt. This view was corroborated by heating the metal unequally, when a crop of crystals appeared in the cooler part of the liquid. Again, two silver rods connected together were plunged, the one in a hotter, the other in a cooler part of fused silver chloride, and at the end of fifteen minutes the latter was studded with crystals of silver, while the former was clean. A galvanometer showed a stronger current between the rods the greater the difference of temperature between the parts of the fluid in which they were placed, and transposing the rods reversed this current. These experiments bear on the nature of voltaic action, and form a lecture illustration of the conversion of heat into electricity and chemical force.

Mr. W. H. Walenn stated that he had found, when zinc is immersed in an electro-brassing solution, crystals of brass (*i. e.*, zinc and copper) were deposited on it.

Capt. Abney exhibited a number of photographic negatives, taken by himself and Col. Festing by radiation through thin sheets of ebonite. The light from the positive pole of an electric lamp was sent through a thin sheet of ebonite, 1-64th inch thick, and photographs taken showed the radiation to have a low wave-length from 8,000 to 14,000. The carbon-points of the lamp could be photographed through the sheet, and Col. Festing observed the sun's disk through it. The ebonite showed a grained structure, and different examples of ebonite gave different results, but all gave some result in course of time at least; old ebonite, like that used in some of Mr. Preece's experiments, scattering the light more than new ebonite.

Dr. Moser exhibited the passage of the rays through the ebonite to the audience, by means of a galvanometer.

Prof. Guthrie observed that Capt. Abney had proved that light as well as heat traversed the ebonite.

Dr. Coffin stated that the composition of ebonite, apparently the same, might vary considerably, and hence its transparency might vary too.

Prof. Helmholtz addressed the meeting on the Localization of Objects by the Eyes. We estimate distance with one eye by the outlines of the more distant objects being covered by the nearer ones where they meet, and by the shadows thrown by the anterior objects. These conditions are very rarely overpowered by others, as, for instance, binocular vision. This is shown by Dove's pseudoscope, and the fact that closing or blinding one eye makes little difference to the power of judging distance, especially when not very close to the eye. The relative shifting of objects as the eye is moved from side to side, or to and fro, or up and down, which may be called the parallax of motion of the head, is also a strong factor in estimating distance. The author had concluded from a study of the stereoscope that the perception of the absolute convergence of our eyes is very indistinct, and that only differences of convergence related to apparently near or distant objects produce the stereoscopic effect. More recent observations of his show that the incongruity between the degree of convergence and the parallax of motion is perceived with great accuracy.

Dr Stone remarked that a person suddenly blinded in one eye acquires a new judgment of distance by moving the head (a habit seen in nocturnal birds); and in taking certain French stereoscopic pictures, the camera is shifted from one

point to another, so that the combined images produce an impression of smallness in the object. These facts corroborate Prof. Helmholtz's view.

Mr. Lewis Wright pointed out that santonin, which changes the sense of color, also appears to change the sense of distance.

PHILOSOPHICAL SOCIETY OF GLASGOW, FEBRUARY 21, 1881.

MR. J. MACTEAR, F.C.S., F.I.C., President, in the Chair.

MR J. J. COLEMAN, F.C.S., F.I.C., read a paper "On the Removal of Aqueous Vapor from the Atmosphere." He said: The absolute weight of moisture contained in any given volume of air, and at any particular temperature, is usually calculated from a table of vapor-tensions by a formula well-known to meteorologists, so that the accuracy of the results depend upon the care with which the table of vapor-tensions has been compiled from direct experiment. Fortunately for this as well as other branches of physics, we have the exact experiments of Regnault, which, in the case in point, were carried down to about 20° below zero of Fahr. scale: but as at that temperature the tension of water vapor is only 0·017 of an inch of mercury, it is quite obvious that errors of experiment would be apt to increase to a serious extent in carrying observations to lower temperatures by the method adopted by this experimentalist.

One of the earliest papers that the late Professor Rankine wrote was one on the "Elasticity of Vapors" (*Edinburgh New Philosophical Journal*, July, 1849), in which he says: "I have obtained among other results an equation giving a very close approximation to the maximum elasticity of vapor in contact with water," and from three constants—viz., the vapor-tension at 220° C., at 100° C., and at 26° C.—he calculated theoretically the vapor-tensions for every 10°—from 230° to 25° below zero, which corresponds almost exactly with Regnault's experiments. In reference to this formula, Prof. Rankine observed that it may be employed without material error for a considerable range beyond what he proved it, but that it can be only regarded as an approximation to the exact physical law of the elasticity of vapors for the determination of which many constants are still wanting which can only be supplied by experiment. The principal point involved in such an inquiry is the question as to whether aqueous vapor ceases to have elasticity at any point short of absolute zero. Passing, however, from such remote considerations, and directing attention to the absolute weight in grains per cubic foot of vapor at various temperatures, I have been led to notice the ratio in which vapor is liquefied by regular diminutions of temperature from 100° F. above zero down to zero itself.

On the tabular statements accompanying this paper I have given two columns of figures, the first column up to half its length containing the actual weight in grains of a cubic foot of saturated vapor, as given in Glaisher's hygrometric tables, and for temperatures which decrease at the uniform rate of 10° down to zero. Directly underneath these figures I show the ratio in which the weight decreases for every drop of 10°. Thus saturated vapor, in dropping from 100° to 90° deposits 25 per cent. of its weight; from 90° to 80°, 26 per cent. of its weight; from 80° to 70°, 27 per cent of its weight, and so on, the ratio increasing almost uniformly at the rate of 1 per cent. every fall of 10°; so that by the time the temperature gets to 10° above zero it parts with 35 per cent. of its weight in falling 10° lower to zero. It seems reasonable, therefore, to suppose that some similar ratio of decrease will be maintained for temperatures far below zero, and in accordance with this view I have ventured to extend the line of figures to a temperature of 120° below zero, from which I have calculated the figures on the remaining half of the column above alluded to, thus showing the probable weight of a cubic foot of vapor for every 10° to 120° below zero.

	Temperatures.	Weight of cubic foot of Saturated Vapor in Grains.	Percentage of Weight Deposited for Fall of 10° in Temp.
Glaisher's Tables above zero F.	100	19·84	25
	90	14·85	26
	80	10·98	27
	70	8·01	28
	60	5·77	29
	50	4·10	30
	40	2·86	31
	30	1·97	34
	20	1·30	35
	10	0·84	34·5
	0	0·55	35
Calculated below zero F.	10	0·36	36
	20	0·23	37
	30	0·14	38
	40	0·08	39
	50	0·05	40
	60	0·03	41
	70	0·017	42
	80	0·009	43
	90	0·005	44
	100	0·003	45
	110	0·0015	46
	120	0·001	47

The result can, of course, only be considered as an approximation, for in reality the ratio of liquefaction must be accelerated to insure complete liquefaction at a point above absolute zero; but, at any rate, it is very clear that at a temperature of 120° below zero, a cubic foot of saturated aqueous vapor does not weigh more than the thousandth part of a grain, or 1-536,000 part of the weight of the same volume of dry air at 60°, or about 1 800,000 of the weight of a cubic foot of dry air at 120° below zero.

I have also thought it might be interesting to put the result in the form of a graphic curve, the vertical figures representing the weight of a cubic foot of vapor, and the horizontal figures representing the temperature commencing at 10° above zero, and ending at 100° below zero. One of the most curious facts that strikes the eye is the independent influence of the freezing-point of water upon this curve, although there is a little irregularity. There is no sudden deposition of moisture when the freezing-point is attained—ice, in fact, imparting humidity to air just as water had previously done before the freezing-point was attained.

With a view to consider for a moment the joint effect of cold and pressure upon aqueous vapor, I have now to remind you of a well known law of physics, viz., that when saturated vapor is subjected to pressure it will liquefy in the direct ratio of the pressure, temperature being constant; and also that atmospheric air saturated with aqueous vapor behaves in this respect just the same as if the air were not present. This principle was illustrated by Dalton, who introduced volatile liquids into the Torricellian vacuum of a barometer tube, and showed that the liquids evaporated or recondensed in proportion to the elevation or lowering of the tube in a mercurial trough. Assume, then, that air at 60° F. and saturated with moisture is compressed to 20 atmospheres, and in a surface condenser consisting of a suitable system of tubes surrounded by an ample supply of water at the initial temperature of the air, then 19/20 of the weight of that aqueous vapor should be deposited as dew in the inside of the pipes. If the volume of the air at starting were 1 cubic foot at 60°, then it would contain 5·8 grains of water, and when compressed to 20 atmospheres without change of temperature 5·5 grains would be deposited, and being expanded again to its original volume and pressure, out of contact with the deposited water, it would be found to contain only 3 grains of water.

Going a step further, let us suppose that the same cubic foot of vapor saturated air at 60° is compressed into one-twentieth its bulk in another way, viz., in direct contact with water—say by forcing it into a strong reservoir partially filled with water. Imagine the compressed air and water to be shaken together and then allowed to stand until perfectly quiescent, the temperature being kept at 60°: now let the water be carefully drained away, or detached from the compressed air, and the air be expanded to its former bulk, and it will be found to be drier than it was at the start, as it will have lost nineteen-twentieths of its vapor just as in the former case. Thus we are brought face to face with a curious paradox—that it is possible to dry air by wetting it. Both of the methods of drying air I have thus described are limited in practice by the difficulty on the one hand of getting temperatures under 100° below zero, and on the other hand, of compressing air in a continuous current to higher pressure than 20 atmospheres. But it is manifest that if the two operations be combined, air might be dried so as not to contain more than the 10,000,000th part of its weight of vapor.

It is an interesting question how these figures compare with the result of desiccating air by chemical methods. According to H. C. Debbit (abstract of whose paper on the subject appeared in the *Journal of the Chemical Society*, October, 1876), anhydrous phosphoric acid is the most powerful desiccating agent, and he states that this substance will remove the 2,000,000th part of the weight of air in the form of moisture, even after it has been carefully dried by sulphuric acid at temperatures not exceeding 25° C. When the anhydrous phosphoric acid, he says, was made to act upon air which had been previously dried over sulphuric acid at 50° C. no less than the 1,000,000th part of its weight proved to be aqueous vapor. Calcium chloride seemed to be a worse desiccator than sulphuric acid, or at any rate its power of desiccation seems to be within very small ranges of temperature, as the author observes that if air be dried by passing over this salt at a given temperature, and be brought into contact with a fresh quantity of the salt at a lower temperature, a further absorption of water takes place, but that if the second portion of chloride of calcium be maintained at a higher temperature than the first the air becomes moister.

In reference to this subject it may be interesting to refer to the paper of Professor Tyndall, recently read to the Royal Society, "Upon the Action of an Intermittent Beam of Radiant Heat upon Gaseous Matter," in which he describes experiments made by passing radiant heat through flasks containing varying quantities of aqueous and other vapors. Tyndall shows that the more vapor there is present in air the more easily are the heat pulsations converted into audible noise on the principle of Graham Bell's recent discoveries. Dry air, in fact, gave no sounds whatever which could be detected, while minute quantities of many vapors added to the air occasioned sounds which could be compared in intensity with those of an organ pipe.

Among other experiments he mentions that Prof. Dewar supplied him with four flasks, the first containing air dried by chloride of calcium, the second air dried by strong sulphuric acid, the third by Nordhausen acid, and the fourth by phosphoric anhydride: and, curious to say, the flask containing the phosphoric anhydride emitted the strongest sound, which is the exact reverse of what should be the effect if phosphoric acid were the best desiccant. Even with sulphuric acid, the extreme difficulty of drying air was very evident, for Tyndall remarks that air kept over the surface of this acid for twelve hours emitted sounds, which, however, entirely disappeared when the time of contact was increased to eighteen hours. This beautiful method of investigation will doubtless be followed up, and it is to be hoped will clear up many points connected with the relative deficiency of desiccants.

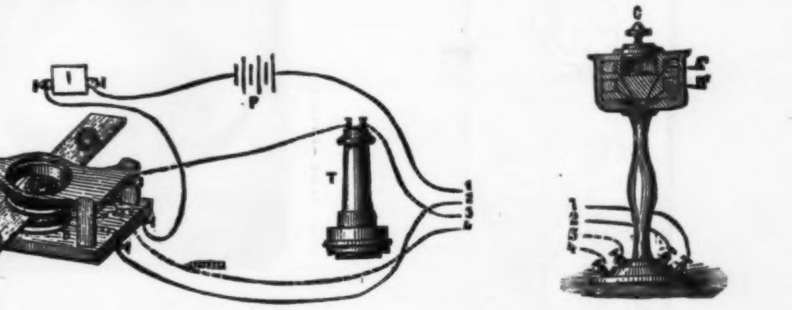
In regard to the strictly mechanical method of drying air described in the first part of my paper, it has been to some extent practically carried out in the construction of Bell-Coleman cold air machines used for the Oceanic conveyance of meat and other provisions. In these powerful machines, and of the size most usually employed in the Transatlantic traffic, about 36,000 cubic feet per hour of atmospheric air are taken into the air compressers; and supposing this air is two-thirds saturated, and of a temperature of 80° F., it contains 37½ lb. water vapor, some of which must be removed before the air is finally discharged from the machine below zero, or the discharged air would become loaded with clouds of snow, which would be a great practical inconvenience. But in point of fact, about half this aqueous vapor is at once deposited, and mingles with the water which is freely injected into the compressor to keep down the heat produced by the compression, and escapes therefrom by a pipe controlled by a ball-cock before the compressed air is allowed to expand; it is made to traverse a great number of small pipes, the external surface of which is cooled by the waste cold air—say of 30°—coming from the provision room being refrigerated. So that by this means a very considerable cooling of the compressed air is effected, causing a further liquefaction of vapor, by which, in fact, its quantity is practically halved.

Thus, by the time the air gets to the expansion cylinder, where expansion takes place in the act of doing work, the air, although it has been freely washed with fresh water, contains only about one-fourth of the aqueous vapor which it contained at the start of the cycle, and can be expanded without producing any inconvenient amount of snow. The temperature at the moment of expansion is generally from 30° to 50° below zero, or 100° below zero when the machine is worked at about four atmospheres of condensation. This method of producing cold dry air has not only been employed in cold air machines working across the Atlantic, but has also been recently found to work well with machinery traversing the Red Sea and Indian Oceans.

AN EXPERIMENT WITH THE INDUCTION BALANCE.

IT would be an easy matter to be a good prestidigitator, were one a good physicist, by putting at the service of the art some of the numerous resources of modern science. A proof of this was well shown by Mr. Hospitalier at a recent soirée given at the Conservatoire des Arts et Metiers, in an interesting and entertaining experiment made by him with one of the most remarkable apparatus of modern times—Hughes' induction balance. The experiment consisted in guessing the value and nature of a piece of money placed at a distance in a covered wooden box, without touching the box or going near it. The apparatus consisted of two parts; one, hidden behind the scenes (represented to the left in the annexed figure), and the other, a wooden box on a foot or standard. Into the latter were thrown the coins whose value was to be guessed. The two parts were connected by four conducting wires twisted together. It is hardly necessary to say that to make the trick as perfect and as striking as possible, the conductors should be hidden, and the binding screws be placed out of sight beneath the foot of the box. The latter might, indeed, be suspended from the ceiling as in the well-known experiment of the magic drum.

Essentially, the apparatus, as employed by Mr. Hospitalier, is composed of four bobbins, A, A', and B, B'. The two latter are placed in the same circuit by the conductors, 1 and 2, and the circuit is completed by a pile, P, and an interrupting apparatus, I. The two bobbins, A, A', are also connected together by the conductors, 3 and 4, and a telephone, 7, is interposed in the circuit. The pile, then, sends interrupted currents into the bobbins, B, B', which



HUGHES' INDUCTION BALANCE APPLIED TO PRESTIDIGITATION.

develop induced currents in the bobbins, A, A'; but the winding is such that the action of B upon A counterbalances the action of B' upon A', provided the bobbins are very equal and placed at equal distances apart. As it is impossible to realize this in practice, the bobbin, A, is placed upon a movable support and the distance is regulated by the screw, V. When the induced currents are well in equilibrium the telephone, T, placed in the circuit of A, A', is silent. If now, the apparatus being ready, a piece of money be placed in the box, C, the equilibrium will be broken because of the induction screen formed by the money, and there will be heard in the telephone the tic-tac of the interruptions produced by the clock-work movement in the conducting circuit. To cause silence in the telephone it will be necessary to introduce between the bobbins, A and B, a piece of money *identical* with that in the box. In his experiments, Mr. Hospitalier used strips of wood upon which he had glued a set of French coins of different values. By sliding one of these strips rapidly along and allowing each coin to rest for a moment in the center of the bobbins till one of them produces silence in the telephone, that piece will correspond with the one in the box. If no piece in the collection produces silence, it will be because the money in the box is either a foreign piece or a counterfeit.

DOUBLE-ACTION MERCURIAL AIR-PUMP.

IN the construction of the air pump represented in the accompanying figures (Figs. I. and II.) it has been Mr. Neesen's design to have a double action mercurial air-pump on a simple system, in which one glass bulb becomes filled with mercury while another is emptying, the same quantity of mercury being used for the two bulbs. Besides this, the inventor has endeavored to avoid, as far as possible, the use of cocks and other metal parts, so that the mercury shall come in contact with glass only. Finally, he has aimed to have an apparatus which shall operate in as simple a manner as possible, and also be of low price. Fig. I. shows a sketch of a pump which satisfies all these conditions. A and A_1 are two glass bulbs similar to those used in the ordinary Geissler mercurial pump, and which terminate in two glass tubes, H and H_1, through which the mercury enters and leaves them. To the sides of these tubes are soldered the narrow tubes, C and C_1, which rise to a height of about 32 inches, and there, bending at right angles, unite with each other. At the point of juncture there is soldered a tube, F, which leads to the apparatus in which a vacuum is to be created.

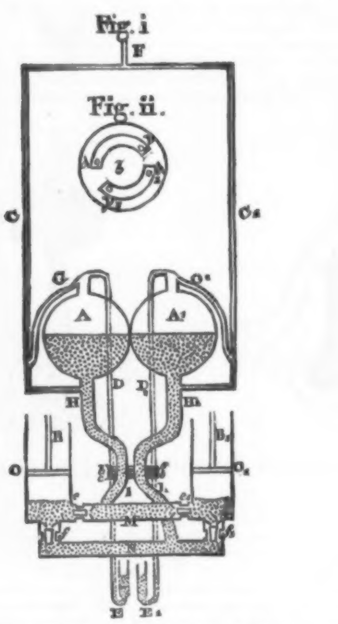
The tubes, H and H_1, pass through a steel disk, *a*, to which they are cemented with shellac. Another steel disk, *c*, is fixed at a certain distance from the other, and between the two there is a third one, *b*, which is capable of being rotated. Into the disk, *c*, there are cemented two glass tubes, I and I_1, which lead to two horizontal tubes, M and N—the two lat-

ter being cemented to two glass cylinders, O and O_1. In the tubes, M and N, there are four glass valves, e and e_1, and f and f_1, the two latter opening toward the cylinders, O and O_1, while the two former open toward the tube, M. The cylinders, O and O_1, contain two pistons, B and B_1, which, during the operation of the apparatus, move in opposite directions.

The bulbs, A and A_1, are, in addition, furnished at their upper extremity with the arrangement which was devised by Toepler to automatically prevent the ingress of external air. For this purpose there are provided the narrow tubes, D and D_1, which are about 30 inches in length and turned upward at the lower end.

The central disk, b, is arranged as shown in Fig. ii. It contains two slots, each of which embraces an angle of about 120 degrees. The two apertures of the tubes, H and H_1, in the disk, a, are represented at α and α_1; and those of the tubes, I and I_1, in the disk, c, by γ and γ_1. If the disk, b, be revolved 90 degrees, the tube, H, will be put in communication with I_1 and H_1 with I, while in the position represented in the cut, H is in communication with I, and H_1 with I_1.

The apparatus is filled with mercury up to the points shown by the dotted lines, this being effected by removing the pistons, B and B_1. Supposing communications established as shown in the figure, the apparatus works as follows: The piston, B, is raised, and B_1 depressed; thereupon the pressure of the mercury in the tube, H_1, causes the valve, f, to raise, and some mercury passes from the bulb, A_1, into the cylinder, O. As a consequence of the descent of the piston, B_1, the mercury in the cylinder, O, passes through the valve, e_1, into the tube, I, and the bulb, A. The valves, e and f_1, are closed. If now, B be depressed and B_1 raised, the valves, e and f_1, will open, while e_1 and f will close; and thereupon mercury will rise from the cylinder, O, into the bulb, A, and will be drawn by suction from A, through the cylinder, O_1. By this means the bulb, A, gradually becomes filled, while A_1 becomes emptied. The mercury in the branch, E_1, of the tube, D_1, and which rises in the latter, automatically prevents the ingress into the bulb, A_1, of the external air. The bulb, A_1, is connected with the receiver from which it is desired to exhaust the air, by the glass tube, C_1; and when the mercury has descended below the orifice of the connecting tube, G_1, the air from the receiver to be exhausted passes into the upper part of the bulb, A_1. The tube, G_1, is necessary in order to



DOUBLE-ACTION MERCURIAL AIR-PUMP.

prevent the concussion of the ascending air. The mercury which ascends the tube, C, in measure as the bulb, A, fills up, automatically prevents the ingress of air into the latter; and the air expelled from A finds an outlet through the tube, D.

When A is filled with mercury and A_1 is empty, the disk, b, is caused to rotate 90 degrees, and the *role* of the two bulbs, A and A_1, is then reversed. Connecting the two bulbs by the tubes, C and C_1, has still another advantage in that it prevents the mercury from rising sufficiently to enter the apparatus which is being exhausted. Were the pressure to become too strong in the bulb, A, the mercury would flow into the bulb, A_1, through the tubes, C and C_1.

The glass valves have been found to be very certain in their action. The travel of the pistons is regulated in such a way that the one which is ascending traverses, in the same length of time, two or three times the distance that the descending one does. These pistons do not need to be so air-tight as those found in ordinary air-pumps. The inventor uses steel as a material for the disks, a, b, and c, because of the liability of glass in such positions to break; but the disks must be mercury-tight, and when they are well polished it is unnecessary to use any lubricant on them.

MAGICAL PITCHERS AND DRINKING VESSELS.

THE accompanying figures, borrowed from a recent work on "Scientific Recreations," by the editor of *La Nature*, represents a magic vase and pitcher such as the ancients were accustomed to employ for the purpose of practicing a harmless and amusing deception on those who were not acquainted with the structure of the apparatus. For instance, if any one should attempt to pour wine or water from the pitcher shown in the cut, the liquid would run out through the apertures in the sides. But the person who knew how to use the vessel would simply place his finger over the aperture in the hollow handle (Fig. 2) and then suck through the spout, A, when the liquid would flow up through the handle and through a channel running round the rim of the vessel and so reach the spout. These magic vases, cups, pitchers, etc., were not only in use among the ancients, but were quite common in the eighteenth century, and numerous specimens are to be seen in European collections. The ones shown in the accompanying cuts are preserved in the Museum at Sèvres. These apparatus are all based on the use of concealed siphons, or, rather, their construction is based on the principle of that instrument. Devices of this kind admit of very numerous modifications. Thus tankards have been so contrived that the act of applying them to the lips charged the siphon, and the liquid, instead of entering the mouth, then passed through a false passage into a cavity formed for its reception below. By making the cavity of the siphon sufficiently large, a person ignorant of the device would find it a difficult matter even to *taste* the contents, however thirsty he might be. Dishonest publicans whose signboards announced "entertainment for man and beast," are said to have thus despoiled travelers in old times of a portion of their ale or mead, as well as their horses of feed. Oats were put into a perforated manger, and a large part forced through the openings into a receptacle below by the movements of the hungry animal's mouth. Heron, in the eighth problem of his Spiritalia, figures and describes a magical pitcher in which a horizontal, minutely perforated partition divides the vessel into two parts. The handle is hollow and air-tight, and at its upper part a small hole is drilled where the thumb or finger can readily cover it. If the lower part of the pitcher be filled with water and the upper with wine the liquids will not mix as long as the small hole in the handle is closed; the wine can then be either drunk or poured out. If the hole be left open for some time, a mixture of both liquids will be discharged. "With a vessel of this kind," says an old writer, "you may

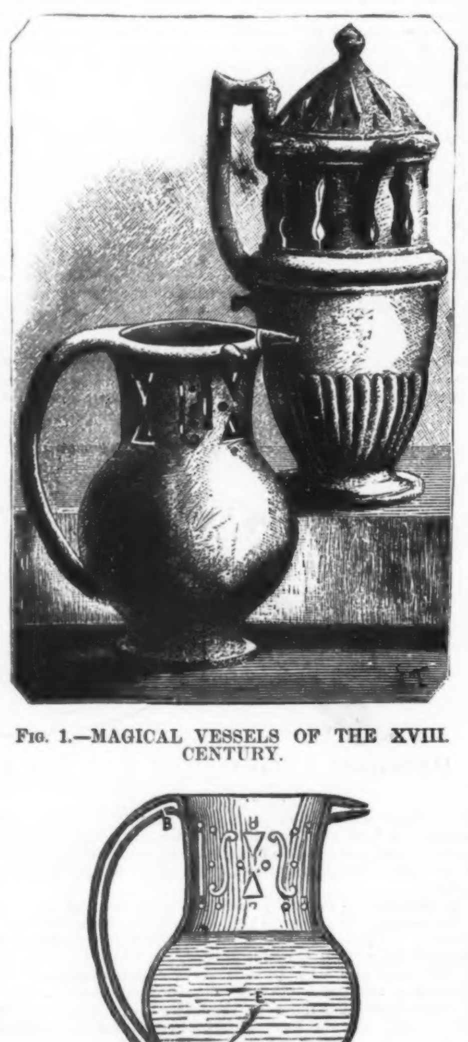


FIG. 1.—MAGICAL VESSELS OF THE XVIII. CENTURY.

FIG. 2.—SECTION OF A MAGICAL PITCHER.

welcome unbidden guests. Having the lower part already filled with water, call to your servant to fill your pot with wine; then you may drink unto your guest, drinking up all the wine; when he takes the pitcher thinking to pledge you in the same, and finding the contrary, will happily stay away until he be invited, fearing that his next presumption might more sharply be rewarded." Another old way of getting rid of an unwelcome visitor was by offering him wine in a cup having double sides and an air-tight cavity formed between them. When the vessel was filled some of the liquid entered the cavity and compressed the air within; so that when the cup was inclined to the lips and partly emptied, the pressure being diminished, the air expanded and drove part of the contents in the face of the drinker. Another goblet was so contrived that no one could drink out of it unless he understood the art. The liquid was suspended in cavities and discharged by admitting or excluding air through several secret openings.

WHOOPING cough has been successfully treated by Dr. Baréty, of Nice, by turpentine vapor. By accident, a child severely affected, was allowed to sleep in a room, recently painted and redolent with turpentine odor, when noticeable improvement took place. Dr. B. has since employed this drug, placed in plates and allowed to stand in the rooms occupied by whooping cough patients. He holds that the disease is mitigated and its duration lessened by this simple expedient.

THE NEW STATE INSANE HOSPITAL, NEAR NORRISTOWN, PENNSYLVANIA.

PENNSYLVANIA, the keystone of the federal arch, has been justly celebrated as one of the chief cultivators of the arts of peace and good will to all mankind, her coal, oil, and iron, have built up the commercial prosperity, not only of the State, but of the whole Union. In all the benevolent and philanthropic efforts to improve, ameliorate, and benefit mankind, she has been always in the front rank. This State has been also careful of the poor, the blind, halt, and the lame; as well as the deaf, dumb, and insane. This latter class makes the strongest and most urgent appeals to the sympathies and benevolence of her people, and she has not been lukewarm in providing for their wants.

The first State Lunatic Hospital was established at Harrisburg, in 1851; but in spite of all the care and attention given to its administration, it was not sufficient to accommodate the increasing number of patients that were constantly applying for aid, nor was there sufficient space to properly classify those that were received, to give the best opportunities for cure.

The Western Pennsylvania Hospital, at Dixmont, near Pittsburg, was opened in 1856. This is a general hospital, and like that at Philadelphia, has also a department for the insane.

The second State Hospital for the Insane was, therefore, built and opened November 1, 1872, at Danville, with a total capacity of seven hundred. In the above institution there is a board of trustees, who meet once a month, or oftener, but the physician is the chief executive officer, not only attending to his own special duties, but also all the others. Again it was found that the capacity of this hospital was not sufficient for all the demands, and the insane department of the Philadelphia hospital was so crowded that it became unfitted for the proper treatment, so that the present hospital for the Southeastern District of the State had to be built. It has been in operation one year in September, and the number of patients in the hospital is six hundred and ninety-four, its full capacity being seven hundred. Part of the patients now in the wards had to be removed from the hospital at Danville, owing to a recent fire that destroyed one half of that building. The hospitals at Harrisburg, Danville, and Philadelphia are all under the old system of a moderate amount of restraint, the chief physician being a male.

This new hospital, near Norristown, is under the system borrowed from those of Belgium—small, separate buildings, with no restraint but the watchful care of the nurse or attendant; all the patients are free, inasmuch as no sort of wristlets, strait jackets, muffs, etc., are used; and even the very noisiest and most excitable patients were, with one exception, allowed to walk about during our visit. On careful inquiry about this class—some of whom are very destructive, and some have a suicidal tendency—we were told that the day previous one of the men was about to attack Dr. Cass; he had his coat off, and the Doctor, looking him in the eye, inquired about the weather, and so the patient's attention was diverted. Another case, in which Miss Alice Bennett, the physician who has entire charge of the female patients, with an assistant, Miss Anna P. Kugler, were going through the ward, a violent woman sprang at the former, and would have hurt her, had not the attendant caught her, and placing her arms round her passed her into her room and locked the door.

Sufficient time has not elapsed to be able to judge of the working of this free system and the division of labor of male and female departments, and we prefer to give a few extracts from the joint reports of the two chief physicians. When the report was made, Oct. 1, 1880, the whole number of patients was five hundred and forty-four—two hundred and forty-one males and three hundred and three females, native born and foreign. The chief alleged physical cause of insanity in the males was intemperance, and the chief moral cause, domestic trouble. The chief form of insanity was chronic mania, of which there were one hundred and eleven cases; then followed dementia, one hundred and thirteen. There were fourteen who had a homicidal disposition. The mortality from July 12, 1880, to September 30, 1880, seven cases. Discharged from institution, two recovered and one improved. During the month of August there was admitted into the men's ward of this hospital the almost unprecedented number of two hundred and twenty-seven patients, ranging from the mildest to the most active and dangerous types of insanity. Not a single accident occurred. Of this number, one hundred and twenty-five were from the Insane Department of the Philadelphia Hospital. Subsequently, one hundred and forty more were received, making the whole number of patients Philadelphia has supplied and is paying for, two hundred and sixty five, which makes the hospital, although somewhat removed beyond the city limits, practically a Philadelphia institution.

The institution is constructed on the plan of detached wards and supply buildings, with connecting corridors—the first two male ward buildings are parallel to each other, on the linear plan, the second one receding in the usual manner, except that it is entirely detached from the first; the third building is situated at right angles to the others; and the fourth or refractory ward building is built upon lines running parallel to the first. The hospital faces the southeast side, which gives a plentiful amount of sunshine in the wards both morning and afternoon. The buildings for patients are two stories in height, and within are light and cheerful in every part. The number of wards are sufficient (sixteen for males) to admit of a very thorough classification of the different grades and types. The institution has most of the modern improvements in hospital appliances, both in and out of the wards, and many minor devices and conveniences which are peculiar to itself.

Dr. Cass writes: "One of the older Asylum Superintendents once remarked that the most important consideration in the care and treatment of insane patients in hospitals is the provision for the violent class. While this institution will rank favorably in most respects with any, it is in the wards intended for the untrustworthy that the most admirable adoption exists.

"The term moral treatment is used to designate all of the restorative means that are employed in the treatment of the insane aside from medical agents, and in this division occupation and amusement are the main resources.

"Employment prudently selected and conducted is especially regarded as an important curative means in insanity. As such, it will be turned to account. Already there are employed in various ways about the hospital nearly one-third of the whole number of male patients, and this force will be increased judiciously from time to time."

In the female department, the report of Dr. Alice Bennett states:

"In this period of two months and nineteen days two hundred and one patients were admitted. Four patients have been discharged recovered; all were inmates of the hospital for less than two months; the whole duration of the disease, in three cases, did not exceed three months; one had been an inmate of another hospital for eight months, and for her change of scene seemed to work a benefit as sudden as it was gratifying. Six deaths have occurred. Realizing the value of the 'moral treatment' of mental disease, realizing, also, that this consists more in the every day—and every hour—influences brought to bear upon each mind than in any special devices for their occasional division on entertainment, however important these may be as aids, it has been the aim of the trustees and medical officers to secure a high order of service in the wards, and in this they believe they have been, in some measure, successful. It is aimed to make each ward a home, whose influences shall be elevating, and where justice and kindness to all are assured. Work is encouraged as a sovereign remedy. Various means of occupying and interesting patients, to be found in the older institutions, are lacking, but with sewing, plain and ornamental, reading, which has been supplied in limited quantity by a few friends, the general work of the ward, with occasional days at the laundry and kitchen, the time has not seemed to hang heavily, and a general spirit of contentment has pervaded the wards."

"In the treatment of the excited class, mechanical restraint has been used in a few cases only, and is now, practically, in disuse. Several 'violent cases, brought from other institutions under some form of restraint that had become habitual from months of use, have been released at once upon their admission, with most satisfactory results.

"Nothing is more certain than that mechanical restraint is incompatible with 'moral treatment,' and that resort to it destroys at once any personal influence that might otherwise be brought to bear. Whether a confession of fear on the part of the attendant, or a substitute for the latter's vigilance, it can hardly fail to lessen the bond of respect between patient and attendant, which it is *essential* to preserve. The patient is humiliated by her chains, and often the most vicious propensities are aroused. For example: Among the cases referred to was a woman whose hands had been confined by 'the muff' for six months continuously. As a consequence she had learned to use her feet with a force and accuracy of aim that made them far more effective weapons of offence than her hands could be, and by the simple release of the latter she was at once a less dangerous companion for other patients. By judicious firmness on the part of attendants, who must know no fear, never get in a passion, but treat the patient with uniform kindness, and, above all, with uniform justice, patients like the one described may be brought under control as much more complete and efficacious than mere mechanical restraint, as it is higher and more desirable. Too much cannot be expected. Untrained, savage natures, which have never known self-control, will not at once respond to the higher stimulus. These require the utmost vigilance and the utmost patience, but surely each of the lowest and apparently most hopeless of these unfortunates may claim our best endeavor."

"I would not be understood as placing myself among the radical advocates of non-restraint. In some rare cases restraint may be justifiable as a protective measure; I have even heard it said that it is sometimes remedial; but is not the good it *may* do so surely modified by the evil it *must* do as to lead all thoughtful persons to pause and carefully balance the two before resorting to it?"

The hospital building No. 1 of the original plan, intended for violent female patients, was not erected, by reason of a lack of funds. Consequently, another building, not adapted to the treatment of this class of patients, is now being used for that purpose. The natural increase of patients has filled the female wards, and it is, therefore, essential that the No. 1 building be erected during the coming season. There are many other improvements needed to complete the plan devised for this institution, for all of which the following estimate is made:

No. 1 building, corridor, etc.	$95,000
Grading, drainage, and roads	10,000
Fencing	7,500
Exercising yards	3,000
Ice house, dam, and slaughter house	4,500
Coal bin and track	1,500
Barn and root house	5,000
Porter's lodge and entrance gate	5,000
Screens for windows	1,500
Covering for corridors	20,000
	$153,000

An appropriation of $20,000 will be needed for additional furniture and equipment, and $5,000 for farming stock and utensils.

The legislature has been asked to appropriate $150,000 for this purpose. Several members opposed the appropriation, on the ground that it was not absolutely necessary, and to convince them to the contrary, an invitation was extended to them and others, by the trustees, to visit the institution on Saturday, March 19, and make a most careful and thorough examination of the whole building, which they did, and from the tone of their remarks we were entirely satisfied that they would make the appropriation. The institution is under an admirable non-partisan set of trustees, many of them devoting much of their valuable time and talents to it, and we feel that it will ultimately prove a great boon to the class of society for which it was built. Several well-known medical gentlemen are connected with it, and the following were in attendance, in spite of a pouring rain: Dr. John Atlee, of Lancaster, who made an admirable speech; Dr. Arnholt, of Pittsburg, and Drs. Diller Luther, Laurence Turnbull, N. L. Hatfield and Weist, of Philadelphia; Dr. Kearn, of Bath; and Dr. Martin, the able secretary, of Allentown.

Much kindness and courtesy were received by your reporter, and he desires to express his thanks to the President, General Hartranft, and Treasurer, B. K. Jamison, Esq., also the Chairman of the Executive Committee, W. D. H. Serrill, Esq., of Darby, and other members of the Board of Trustees.—*Medical and Surgical Reporter.*

RECTAL ALIMENTATION.—From experiments made in Prof Vulpian's laboratory, M. Catillon infers that in order to secure the full nutritive benefits of injected foods, they should first be transformed into peptones. For one enema he used: peptone of meat (the solution saturated at 19° C.), forty grammes (about an ounce and a half), water, one hundred grammes (about three and a half ounces), laudanum a few drops, and bicarbonate of soda thirty centigrammes (four and a half grains).—*L'Abeille Méd., in Journ. de Méd. de Brux*

FLAX AS A CARRIER OF DISEASE.

A FATAL fever has been imported into Ireland in foreign flax. Many deaths have occurred in Tandragee, in County Armagh. This town contains between ten and fifteen thousand inhabitants. A great deal of flax is used for manufacturing purposes, which is imported from Manila, China, India, and the Baltic provinces of Russia. The manipulation of flax forms the principal industry of the town. It is stated by eminent physicians that the flax-growing countries are capable, owing to the habits of the people, of generating every distemper known to medical science. The great London epidemic of 1865 was traced to infected clothing on two Turkish ships, and it cost the government $100,000 to have the vessels destroyed. The present epidemic in Tandragee doubtless had a similar origin and its effects are beyond conjecture, unless physicians ascertain the exact nature and cause of the disease and find remedies with which to destroy it.

Dr. Wilkinson, of the New York Medical College, in conversation with a representative of the New York press, relative to the disease, said:

"The ports that flax come from are hot-beds of all the terrible diseases that afflict us. In that product is imported cholera, ship fever, yellow fever, and a dozen other fevers for which it is difficult to find technical names. The disease at Tandragee may be the ship fever in one of its known forms, or some other sickness with the nature of which medical men are acquainted, but nothing positive will be known under seven days after the first symptoms are discovered, because no fever develops itself in less than that time. Russia ought to be called the great plague country. The lower classes among her people are the filthiest on the face of the earth, and they exceed any other nation in breeding pestilence. In cold weather, when cholera ought to be frozen out, they lock themselves up in unventilated rooms that are kept at summer heat by blazing fires, take no exercise, hardly ever wash their persons, and never change their clothing until it drops from them piece by piece. The result is natural. They are affected with all deadly diseases known, many of which originate through their unclean habits."

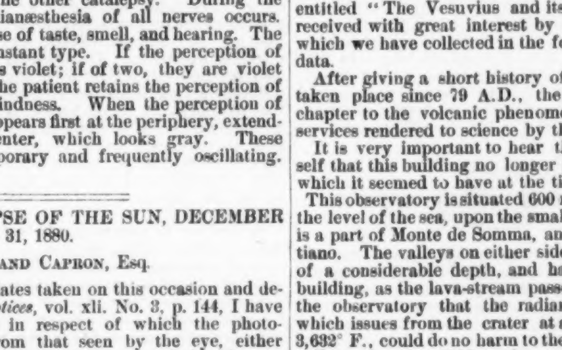
CHARCOT ON HYPNOTISM.

CHARCOT has delivered a lecture on hypnotism at the Salpêtrière, demonstrating on a patient the essential features of this nervous state. He considers that hypnotism is a real pathological condition, precluding any possibility of simulation on the part of the persons experimented upon. Hystero-epileptics are most susceptible to the hypnotizing influences; it is merely sufficient to fix their attention for a brief period of time on some object in order to throw them into this morbid sleep. At this stage of hypnotism their neuro-muscular apparatus is in the state of overexcitability. By touching any nerve-trunk the muscles supplied by it are made to contract, and the spasm lasts as long as the nerve is acted upon. When this ceases the muscles relax. If the eyes of the patient are now opened the preceding lethargy is replaced by the cataleptic condition, the limbs retaining any position given to them. Although the lethargy and catalepsy exclude each other, under certain circumstances they can coexist. This occurs if only one eye is opened, when on one side is lethargy and on the other catalepsy. During the hypnotic condition hemianæsthesia of all nerves occurs. Persons may lose the sense of taste, smell, and hearing. The color-blindness is of a constant type. If the perception of only one color is lost, it is violet; if of two, they are violet and green. As long as the patient retains the perception of violet there is no color-blindness. When the perception of a given color returns, it appears first at the periphery, extending gradually to the center, which looks gray. These hemianæsthesiæ are temporary and frequently oscillating. —*Gazette des Hopitaux.*

THE PARTIAL ECLIPSE OF THE SUN, DECEMBER 31, 1880.

By J. RAND CAPRON, Esq.

UPON examining the plates taken on this occasion and described in the *Monthly Notices*, vol. xli. No. 3, p. 144, I have found three appearances in respect of which the photographic image differs from that seen by the eye, either unaided or with the telescope. As these are probably always, in a greater or less degree, present in photographs of similar objects, it may be useful to describe them.



1. Round the edge of the solar image, and in a stronger degree where it touches the moon's limb, is the bright line of light seen in most photographs when black is contiguous to white. In portraiture it is well shown, edging a velvet dress, and is then frequently very sharp and definite. This effect—generally termed "photographic irradiation"—has been attributed by Lord Lindsay and Mr. Ranyard to an extension of chemical photographic action on the plate. Others, I believe, have attributed it to a thickening or building up of the chemicals during development. Its appearance and causes have at all events been fully discussed elsewhere.

2. The second appearance not visible to the eye is a halo or ring of light seen some little distance from the sun, and surrounding it except where the moon's limb is in contact. Dr. Berwick, in *Nature* of October 30 and December 5, 1879, has described and figured this form of halo as surrounding a full moon which carried no trace of it to the eye. He was also led to infer that it was only found at full moon, and not during the quadrants. Some experiments I made soon proved this to be a mistake. I found the same ring or halo about a diameter distant from the object, to accompany the imperfect moon, the sun, and other bright bodies.

One photograph of a rising sun shows it strong, though nothing of the sort was visible to the eye, and with the moon images it seemed only a question of time of exposure. When by over-exposure the sun's image was reversed, the halo was so also. As a final experiment I photographed a card with apertures in it, covered by ground glass, and obtained the following results, in which the shading indicates the halos, which were in fact soft and diffused.

The circle gives, like the sun and full moon in the photographs, a truly circular halo. The cross gives a somewhat more complicated image; square internally, and tending to circular externally. The crescent gives a slightly oval halo, strengthening in intensity with the shape of the crescent. Between the horns, however, there is a marked absence of the halo. I am not aware how far this ring or halo, surrounding, it would seem, all bright objects when photographed, has been examined and explained. At present, I am inclined to think it due to the lenses with which the pictures are taken, though very similar halos are frequently seen in certain conditions of the atmosphere or the eye. These last are, however, found in practice difficult to impress on the photographic plate with a short exposure, while with a long exposure the invisible halo always comes out.

3. The last point is a diffused halo or light spreading over the dark portion of the moon projected on the sun. This expands from the contact edge of the sun and moon, gradually lessening in intensity to what would very nearly be the sun's circumference, as indicated in the annexed diagram in which the dotted line shows its limit.

It is very clearly shown in one or two of the longer exposed plates, and at first strongly suggested the idea of a subjective phenomenon. I think, however, it is really due to that form of photographic defect distinguished from "irradiation" by the term "halation," and referred by Lord Lindsay and Mr. Ranyard to reflection from the back of the plate. It is peculiar that it should be convex and not concave in form, and that it should not more plainly accompany the outer edge of the sun. It must, however, be remembered that these pictures are, except as respects the sun's visible disk, necessarily under exposed, and that the moon's limb on the sun presents a much darker background on which such halation would be detected than the adjoining sky.

I may, I think, venture to add that all the foregoing phenomena are yet not entirely and perfectly understood, and fairly merit further attention as having an important bearing on celestial photography.

Guildown, Guildford, March 3, 1881.

PALMIERI'S REPORT REGARDING THE OBSERVATORY OF THE VESUVIUS.

PROF. LUIGI PALMIERI has recently published a pamphlet entitled "The Vesuvius and its History," which has been received with great interest by the scientific world, and of which we have collected in the following the most important data.

After giving a short history of the eruptions which have taken place since 79 A.D., the author dedicates a special chapter to the volcanic phenomena of the mountain and to services rendered to science by the observatory.

It is very important to hear through Prof. Palmieri himself that this building no longer possesses the perfect safety which it seemed to have at the time of its erection.

This observatory is situated 600 m. (equal to 1,968 feet) above the level of the sea, upon the small ridge of a mountain which is a part of Monte de Somma, and extends toward St. Sebastiano. The valleys on either side of this mountain ridge are of a considerable depth, and have probably protected the building, as the lava-stream passed so far below the level of the observatory that the radiant heat of the molten mass which issues from the crater at a temperature of (2,000° C.) 3,632° F., could do no harm to the building or its inhabitants.

From the year 1855 to the year 1872, however, so many lava streams passed through the Fosso della Vetrana and across the Piano della Ginestra, that in consequence of the lava-layers which were gradually formed, the valleys were partially filled up, and although the building is still considerably higher than the surrounding lava-beds, there is nevertheless great danger that in time the valleys will become so high that the heat of the lava-stream will threaten the building itself. During the last great eruption, 1877, by the reverberation of the lava-streams passing to the right and left, the building became so heated that the situation of the inhabitants was anything but pleasant, and the thermometer on the terrace indicated (+74° C.) 185° F.

The erection of the observatory was commenced in 1841, after the plan of the engineer, Gustave Fazzini, and the charge of the new institute was given to the renowned physicist Malldonio Melloni, who was born in Parma. King Ferdinand II., of Naples, in 1831, made the acquaintance of this scientist, who lived, a political refugee, in Paris. This king, induced by the recommendation of Alexander von Humboldt, called him from France.

In 1847 the observatory was completed, and Melloni was sent to Paris for the necessary instruments, but in 1848 the political condition of Italy changed altogether; Melloni lost his position, and nobody cared any longer for the observatory of Vesuvius, which stood empty until 1851. In this latter year Luigi Palmieri, who had been sent by the Academy of Sciences to Melfi to study the phenomena of the earthquake of the 14th of August, returned, and was called upon to give his opinion regarding the fitness of the building for scientific observations, as several objections had arisen against it.

Palmieri, after having proposed some changes which he believed to be necessary, on the death of Melloni, from cholera, in 1861, took charge of the building himself, which at that time stood only under his supervision. In the same year he placed in the observatory the electro magnetic seismograph which he had invented, an instrument which indicates the slightest movement or oscillation of the ground, and which he holds to be the only sure indicator of an increase of the volcanic action of the mountain. He also founded the valuable Vesuvius library, of which the basis was formed by the purchase of Prof. Secchi's precious collection of books treating on Vesuvius.

The scientific body of the observatory at present consists of the director himself, two assistants, and one adjunct.

Palmieri in his publication gives a complete list of the valuable instruments with which the building is supplied, good illustrations accompanying the description of the principal ones.

The benefits rendered to science by the observatory are described by the author as follows:

1. By means of this observatory it has become possible to study the different phases of the volcanic eruptions, in their connection and succession.

2. The peculiar condition and composition of the lava-streams, and their accompanying phenomena, have been more closely investigated.

3. The laws of the formation of the so-called *fumaroles* have been determined.

4. Not only the conditions of the sublimates which form the *fumaroles* have been ascertained, but some perfectly new ones have been discovered.

5. It has been proved that several phenomena accompanying the eruptions, which were hitherto considered accidental, are constantly accompanying them.

6. Many opinions hitherto maintained by scientists have been found to be erroneous, among others, the opinion that ammonia is never found near the crater or other highly elevated portions of the mountain.

7. Finally the close studies of and improvements made in observation-instruments have been made possible by the observatory, and a knowledge of electro-meteoric phenomena has been greatly extended.

It will only be just to make a few remarks in regard to the writer of the pamphlet himself, who has obtained so much fame in the scientific world.

Luigi Palmieri was born April 21, 1807, at Farchia, a small city of the Terra di Lavoro. His first instructions he received from his father, who was a great Latin scholar. Later, he entered the seminary of Cayazzo, and finally went to Naples, where he finished his studies. His remarkable talents procured for him the situation as Professor of Physics at the Royal Lyceum of Naples. In 1845 he obtained a similar situation at the Marine College, and after the death of Pasquale Galuppis, he obtained the chair of physics at the University of Naples, which this renowned scientist had hitherto occupied.

After the death of Secchi Palmieri was elected member of the Meteorological Central Bureau, having been previously elected to the Senate by the Government of Victor Emanuel.

For 25 years he has been Director of the Observatory of Vesuvius, and in this post he has many a time risked his personal safety for the benefit of science. Several times the observatory has been surrounded by the glowing lava-stream, and its inhabitants cut off from all help. In 1850 Palmieri had a very narrow escape from the fate of Empedocles and Plinius the Elder, and in 1872 he also encountered many dangers as the brilliant description of the convulsion of this year published in the "Annali dell' Osservatorio Vesuviano"* shows.

THE BORDER-LAND OF CHEMISTRY AND BIOLOGY.

It has become an almost trite saying that just as important minerals are most readily discovered along the meeting-line of different geological formations, and as animal species are most numerous along the edge of the forest or of the river, so the most interesting results are often obtained along what may be called the boundary of two sciences. Of this truth a striking instance is afforded by the researches of Dr. James Blake. This experimentalist has for forty years been engaged with the study of a class of phenomena having both a chemical and a biological aspect, and he has obtained results of great value alike to organic and inorganic science. As far back as 1839 he showed, in a paper read before the Academy of Sciences in Paris, that the physiological action of solutions of different salts injected into the blood of living animals depended mainly upon the electro positive or basic element of each salt, and were little modified by the electro-negative element or acid. Thus, to take a simple instance, the effects of sodium sulphate differ less from those of sodium nitrate than they do from those of magnesium sulphate.

Again, in a memoir communicated to the Royal Society, in June, 1841, Dr. Blake proved that the action of inorganic substances conveyed directly into the blood of living animals depended on their isomorphous relations—those bodies which can replace each other in a crystalline compound without disturbing its form having similar physiological action.

A third step was taken in a discourse delivered before the California Academy of Sciences in 1873, the author showing that among metallic bodies the physiological activity of those belonging to one and the same isomorphous group is proportionate to the atomic weights; the higher the atomic weight the more intense is the physiological action.

Finally, in a paper communicated to the German Chemical Society, on February 7th of the present year, Dr. Blake sums up the whole of his results. The first point to be noticed is that the effects obtained were the same in all the species operated upon—horses, dogs, cats, rabbits, geese, and hens. It might, indeed, have been wished that some ruminant animal and some species of monkey had been inserted in the list. The hedgehog, also, in virtue of his alleged immunity from the action of poisons, would have been a desirable subject. Some cold-blooded animal, such as that "martyr of science" the frog, should have been included. These omissions are the more to be regretted since any extension or verification of Dr. Blake's researches is now rendered practically impossible. So far, however, as experiment has gone, we may conclude that the indifference of certain animals to the action of various poisons when introduced into the stomach is due mainly to non-absorption.*

The substances employed were salts of forty-one of the chemical elements. They were dissolved in water, and injected into a vein or artery in known quantities. The fatal doses for each individual were carefully noted, and a kymograph was connected with the femoral artery. The curves described by this instrument were strikingly characteristic for some of the isomorphous groups.

Among the monatomic metals tried were lithium, sodium, rubidium, thallium and silver. All agreed exactly in the mode of their physiological action, but the fatal dose for rabbits, which was 1 grm. per kilo of the weight of the animal for lithium sulphate fell to 0·06 grm. for silver nitrate. In other words, lithium sulphate, to kill, must be introduced in the proportion of 1 part per thousand of the living weight, while of silver nitrate 6 parts per 100,000 suffice.

Among the group of the diatomic metals Dr. Blake experimented with the salts of magnesium, iron, manganese, cobalt, nickel, copper, zinc, and cadmium. Here, again, the physiological action is similar, the fatal dose being 0·97 grm. per kilo for magnesium sulphate and only 0·08 grm. per kilo for cadmium sulphate.

The salts of calcium, strontium, and barium agree also in their physiological action, which is intensified from 0·47 grm. per kilo in calcium chloride to 0·043 grm. in barium chloride. The salts of this group produce contractions of the voluntary muscles, even thirty to forty minutes after the action of the heart has ceased. The reactions of lead salts resemble exactly those of the barium group, but at the same time they agree in some respects with those of the salts of silver.

Among the tetratomic metals the author examined those of thorium, palladium, platinum, osmium, and gold. All have very intense physiological action, ranging from 0·129 grm. per kilo in thorium sulphate to 0·003 grm. for gold chloride. The characteristic of this group is their effect on the action of the heart. Salts of gold introduced into the blood, even in the minute proportion of 0·003 or 0·004 grm. per kilo, keep up the action of the heart for several hours after death, though the body may have cooled down as far as 55° F. below its normal temperature. We may here ask if this is not the explanation of the action of platinum chloride in prolonging the life of animals bitten by the cobra?

Among the hexatomic metals the salts of glucinum, aluminum, and iron (ferricum) were found to agree in their physiological action, the death-dose being 0·023 grm. per kilo in the first, 0·007 in the second, and 0·004 for iron, all in the form of sulphates.

Here we are, in the first place, struck with the difference between iron in its two classes of salts, the ferrous and the ferric. Of the former the fatal quantity is 0·115 grm. per kilo, or twenty eight times as much of the latter.

We next perceive that the distinction between poisonous and non-poisonous substances is reduced to a mere question of proportion. The dogma that "whatsoever is poisonous in large doses is poisonous also in the smallest, though the injury done may escape notice," falls at once to the ground if we reflect that the very salts which naturally occur in and form necessary parts of our blood become deadly in a somewhat larger quantity!

Among the non-metallic bodies the compounds of chlorine, bromine, and iodine were found accordant in their physiological reactions, but the increase of intensity accompanying the atomic weight was not observed—a most puzzling exception. The identity of action here noted is also peculiar, since bromides taken internally have a very different action from the corresponding chlorides, *e. g.*, in the treatment of sea-sickness. Phosphorus, arsenic, and antimony occasion no immediately perceptible physiological reaction, though if arsenious acid is injected in the proportion of 0·56 grm. per kilo it arrests the pulmonary circulation. Sulphur and selenium agree in their physiological action; the latter, having the higher atomic weight, is the more powerful.

A curious exception to the rule that isomorphous substances agree in their physiological action is afforded by the salts of potassium and ammonium. The effects of the latter approach those of certain nitrogenous alkaloids.

The author suggests that if—as is far from impossible—the carbon-compounds present similar phenomena in their influence upon animal life, a new key to the molecular relations of organic bodies is placed in the hands of the chemist. It is especially to be remembered that in alcohols of one and the same series the intensity of the physiological action rises with the atomic weight, as has been shown by Dujardin. The question in what manner the isomorphous relations and the atomic weights of substances can influence their physiological action can scarcely as yet be entertained.

Still Dr. Blake's researches are exceedingly valuable, both as pointing out a new method of chemical research and as overturning certain erroneous conceptions concerning the nature of poisons.—*Journal of Science.*

REPORT ON ANALYTICAL CHEMISTRY.

ZINC.—*Separation from Cadmium.*—A. YVER.†—The solution containing the two metals as acetates is treated with two or three grammes of acetate of sodium and a few drops of acetic acid and then subjected to electrolysis. The battery used consists of two Daniell's cells of the usual form. The cadmium is completely precipitated upon the negative pole, while all of the zinc remains in solution. The deposition takes place in the cold and is complete within three or four hours, when the quantities of the metals range between 0·180 and 0·210 gramme.

Separation from Copper.—G. LARSEN.‡—A single precipitation with sulphide of hydrogen suffices for a complete separation of the two metals, provided the solution is acid with hydrochloric acid and hot when treated with the gas, and the precipitate is washed with a hot solution of sulphide of hydrogen containing hydrochloric acid.

CADMIUM.—*Separation from Copper.*—G. VORTMANN.§—The dilute solution is treated with hyposulphite of sodium until it becomes colorless, and then heated to the boiling point. The copper precipitates as sulphide.

SILVER.—*Electrolytic Deposition.*—H. FRESENIUS and F. BERGMANN.‖—The tendency of silver to precipitate in a spongy or flocculent condition when deposited from an acid solution by electrolysis can be avoided by employing a weak current and dilute solution. The following conditions were found to be the most satisfactory: A solution containing in 200 c.c. from 0·03 to 0·04 gramme of silver and from 3 to 6 grammes of nitric acid; a separation of the electrodes of one centimeter; a current sufficient to yield from 100 to 150 c.c. of electrolytic gas per hour. From a dilute neutral solution the silver deposits in a flocculent condition however weak the current.

Separation from Lead.—E. DONATH.*—The solution is treated with 4 or 5 c.c. of glycerine, an excess of ammonia, and finally with 10 or 15 c.c. of concentrated caustic potassa or soda. Complete solution ensues. The whole is then boiled four or five minutes, with constant stirring. Lead, also bismuth and copper, remains in solution, while the silver is completely precipitated as metal. The precipitate is washed with hot water, then with hot dilute acetic acid, and finally with hot water again. The washing with acetic acid is necessary in order to remove any carbonate of lead which may have formed in the filter during the first washing with water.

MERCURY.—*Detection in Dilute Solutions.*—J. LEFORT.†—It was shown by Orfila that the gold-tin voltaic couple of Smithson, devised for the detection of minute quantities of mercury, might lead to erroneous conclusions in consequence of the deposition of a portion of the tin upon the gold. It is, however, easy to distinguish a deposit of mercury from one of tin, since by placing the strip of gold foil in a narrow glass tube and heating, the former is readily sublimed, and its presence can be confirmed by exposing the sublimate to the vapors of iodine. A more curious difficulty presents itself when the solution to be examined contains arsenic. The couple reduces the compounds of arsenic quite readily with precipitation, first upon the tin and then upon the gold. When the latter is heated the arsenic sublimes, and cannot be easily distinguished in the sublimate from mercury, especially since the vapors of iodine convert it into a compound whose color resembles that of the iodide of mercury. This chance of mistaking arsenic for mercury should not be lost sight of when defective analyses are seemingly establishing the wide diffusion of mercury in mineral waters.

NICKEL AND COBALT.—H. FRESENIUS and F. BERGMANN.‡ have undertaken to ascertain the conditions most favorable for the electrolytic deposition of nickel and cobalt. They recommend for both a solution containing in 200 c.c. from 0·1 to 0·15 gramme of the metal as sulphate, from 2·5 to 4·0 grammes of ammonia (NH_3), and from 6 to 9 grammes of sulphate of ammonium; a current equivalent to 300 c.c. of electrolytic gas per hour, and a separation of ½ or ¼ c.m. for the electrodes. If less ammonia is used the results are not good. Larger quantities retard the deposition, but do no further harm.

Qualitative Separation of Nickel and Cobalt.—F. REICHEL.§—Both metals are precipitated by caustic potassa. The precipitate, filtered but not washed, is placed in a test tube. A piece of solid potassium hydroxide and just enough water to dissolve it are added. On boiling the cobalt dissolves, and imparts a blue color to the solution. In this way minute quantities of cobalt can be expeditiously detected.

IRON.—*Precipitation by Succinate of Ammonium.*‖—The statement of Fresenius that the precipitate of iron by succinate of ammonium is partially redissolved by heating has been found to be incorrect. The filtrate contains less iron than when the precipitation has been effected in the cold. Hot succinic acid dissolves very little of the precipitate, whether the precipitation has been effected in hot or cold solutions, but more in the latter than in the former case. Cold succinic acid dissolves more than hot. It is therefore recommended to precipitate from hot solutions and to boil two or three minutes before filtering.

ALUMINUM.—*Separation from Iron.*—E. DONATH.¶—The neutral or slightly acid solution is treated with hyposulphite of sodium until all ferric compounds have been reduced. A solution of cyanide of potassium having twice the volume of the iron-aluminum solution, and containing from 15 to 20 grammes of cyanide of potassium, is heated to boiling, and the iron-aluminum solution slowly poured into it. The solution is then quickly cooled, acidified with acetic acid, and the aluminum precipitated with carbonate of ammonium. If the aluminum hydroxide has not a pure white color, it must be dissolved and reprecipitated. The separation is quantitative.

MANGANESE.—*Use of Permanganate in Presence of Hydrochloric Acid.*—C. ZIMMERMANN.**—The usefulness of permanganate of potassium in volumetric analysis is considerably diminished by the fact that it cannot be used in solutions containing hydrochloric acid. The author has discovered that by adding manganous sulphate, this difficulty can be wholly obviated. The solution in which the titration is to be made must, however, contain no free sulphuric acid.

Quantitative Determinations by Potassium Permanganate in Alkaline Solution.—E. DONATH.††—Hitherto this compound has been employed only in neutral or acid solution. Preliminary experiments, however, indicate that it can be successfully used in alkaline solution for the determination of both chromium and manganese. The reactions supposed to take place are as follows:

$$Mn_2O_7 + Cr_2O_3 = 2CrO_3 + 2MnO_2$$
$$3MnO + Mn_2O_7 = 5MnO_2$$

The standard solution of permanganate is rendered alkaline by addition of sodium carbonate and caustic soda, and heated nearly to boiling. The neutral solution of the chromous or manganous compound is then allowed to flow in until complete reduction of the permanganate has been effected.—*H. N. Morse, in American Chemical Journal.*

GLYCOLIC ACID FROM SUGAR.

By H. KILIANI.

LEVULOSE and dextrose in aqueous solution are oxidized by silver oxide to glycolic, oxalic, and carbonic acids, even at common temperatures. Cane-sugar is reduced with the aid of heat, but mere traces of glycolic acid are formed unless the sugar has been previously inverted.—*Liebig's Annalen.*

* An English translation of the description was published by Robert Molet in London.

* This view can scarcely be admitted in case of the remarkable toleration of the salts of morphine in certain apes. That it really enters the circulation is proved by its subsequent appearance in their urine.—Ed. *J. S.*

† Bull. de la Soc. Chim., 34, 18.

‡ Monatshefte fur Chemie, 1, 952.

§ Dingler's Jour., 239, 239.

‖ Zeitsch. f. analyt. Ch., 1880, 394.

* Monatshefte fur Chemie, 1, 789.

† Zeitsch. an. Ch., 1880, 314.

‡ Compt. Rend., 90, 141.

§ Zeitsch. an. Ch., 1880, 468.

‖ Jour. Chem. Soc., 1880, 674.

¶ Berichte d. deutsch. chem. Gesellsch., 1881, 779.

** Monatshefte fur Chemie, 1, 785.

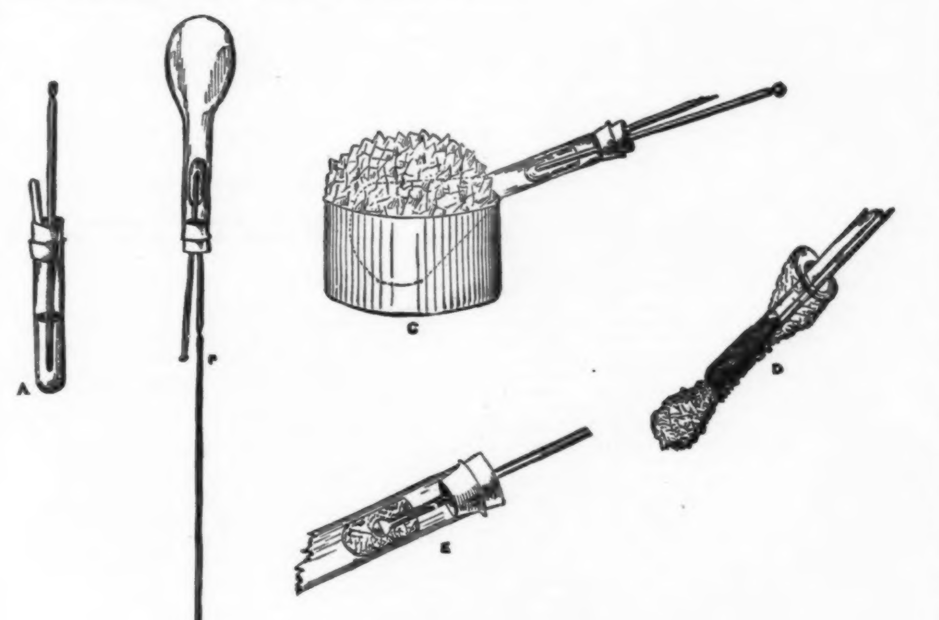
†† Berichte d. deutsch. ch. Gesellsch., 1881, 980.

HOT ICE.

The announcement made some time since by Dr. Carnelley that ice *in vacuo* could be raised to a temperature far above its ordinary melting-point, seemed so thoroughly in opposition to the experience derived from the great work of Regnault on the tensions of vapors; and as it called for a complete change of ideas in a field in which I am much interested, and as Dr. Carnelley asked others to repeat his experiments, I was induced to examine for myself the experiments on which so curious a statement was founded.

I used two different methods; the Torricellian vacuum and the Sprengel vacuum. As the experiment, as conducted by the Torricellian method, can easily be repeated by any one, and is much simpler in form than Dr Carnelley's, I shall detail it. In the first place I wished to obtain a clear continuous piece of ice round the thermometer, as Dr. Carnelley's method gave flaky ice, which I found might lead to errors, owing to its discontinuity leaving the thermometer bare in parts. To obtain clear ice the following method was used: Some distilled water was boiled in a test-tube, A, fitted with a two-holed stopper, with a thermometer through one hole dipping into the water; when all air was expelled, a glass plug was pressed into the other hole against the issuing steam, and the whole allowed to cool, and then frozen in a freezing mixture. A long-necked "German Florence flask" was then rinsed with distilled water and filled with mercury, and also placed in a freezing-mixture. The tube, A, was then gently warmed with the plug of ice adhering to the thermometer withdrawn. The glass plug in the second hole in the stopper was then replaced by a marine barometer tube of about forty inches in length, having been drawn out about four inches from the top to facilitate sealing. The plug of ice round the thermometer was then inserted into the neck of the flask full of mercury, and the stopper pressed home. This caused the mercury to rise in the barometer-tube, and the whole was then inverted as at B; and when the mercury had all run out, the fall tube was melted through at the constriction, B, leaving a Torricellian vacuum above. The flask was now laid on its side in a freezing-mixture and well covered over with ice and salt as at C. After a few minutes, to allow the receiver to cool, heat was applied to the neck of the flask with a Bunsen lamp, and even with a blowpipe, till the glass softened, but the temperature of the thermometer did not rise until some part of it became denuded of ice, or until air had been admitted. The experiment was repeated again and again, but in no case while the vacuum was intact could the temperature of the ice be raised materially above that of the receiver. If the temperature of the receiver was —12°, then the ice was a little over —12°, say about —11°, but never more than two degrees above the receiver, although the glass almost in contact with the ice was at its softening point. This is exactly what we would expect from Regnault's experiments; the temperature of the receiver determines the vapor-tension, and therefore the "boiling point" of the ice. The ice was certainly never hot, and was not even infusible, because when pressed against the hot glass it at once splashed out, freezing again in long thin flakes when it obtained free space for evaporation. All the heat passing to the ice is used up in volatilizing it, and increase of the source of heat merely increases the rate of evaporation, as in the case of water boiling under atmospheric or other constant pressure; provided the condenser be efficient. These experiments were repeated with different thermometers and thicknesses of ice, varying from one half an inch to the thinnest film of one-fiftieth of an inch, or thereby, and the temperature of the ice was always dependent upon the temperature of the receiver (when vacuous) and quite independent of the temperature surrounding it; the latter merely determining the rate of evaporation. Whenever a hole appeared in the ice covering the thermometer the latter rose, and if close to the hot glass, rose rapidly. When the ice were away as shown at D, the temperature registered by the thermometer could be made either over or under zero. If the source of heat was made to play upon the top of the tube, then the temperature would read over zero say 6°, and if made to play on the bottom it would read —8°, the receiver being —12°. When however the ice was made to lie on the upper side of the thermometer by turning the latter round, the temperature could not be raised over zero, and sometimes not over —4°. These experiments were repeated by exhausting with a Sprengel pump, and it was invariably found that the pressure of the gas or vapor in the receiver determined the temperature of volatilization of the ice, and when the "vacuum" contained only water vapor the temperature of the receiver and of the ice round the thermometer (however far apart they were placed) were practically the same. For instance, let the receiver be —5°, then the thermometer in the ice is also —5° or —4°; now let the receiver be suddenly cooled to —14° while the flame round the ice is urged to a higher temperature; the ice will nevertheless fall to — 13° or thereby; in short, the *temperature* of the "boiling" ice is determined by that of the receiver, while the *rate* of its "boiling" is determined by the temperature of the tube surrounding it. The ice remains perfectly dry, but if air be admitted or the receiver be raised above 0°, melting takes place.

As it has been objected that the thermometer might yield anomalous readings under such conditions (though why I cannot see), another method was tried, as shown at E. A small bulb blown on the end of a tube open at the other end and containing a little water, had ice frozen round it, as in the case of the thermometer, and was then placed in the flask as before, so that there was a piece of ice under ordinary atmospheric conditions inclosed in the ice *in vacuo*. The tube round the outer ice was now raised to the softening point, but the ice in the bulb did not melt, and continued solid till the bulb was denuded of external ice by evaporation, showing that the ice *in vacuo* was never over 0°. It appears then that ice cannot be raised above 0° under any circumstances, and that the pressure determines the volatilizing or "boiling" points of both solids and liquids, as Regnault's work would lead us to suppose.—*J. B. Hannay, in Nature.*



EXPERIMENTS WITH HOT ICE.

LOHSE'S METHOD OF PREPARING EMULSION.

In the method of preparing gelatine or collodion emulsion recommended by Dr. O. Lohse in his recent communication to the *Archiv*, the tedious process of washing is avoided. The entire success of the process hinges upon the solubility of gelatine in acetic acid. When gelatino-bromide of silver is formed in a fine state of division in aqueous solution, it is held in suspension, and refuses to precipitate. But if acetic acid (glacial) be added to the solution, in quantity sufficient to dissolve the gelatine, or to utterly destroy its tendency to set, the solution will be broken up, and the silver bromide precipitated in an impalpable powder, which may be readily utilized.

As in the old method, so in the new, it is necessary to have the combining quantities of silver nitrate and potassic bromide so related the one to the other as to produce an emulsion free from fog. It is also well beforehand, to see to the purity of the potassic bromide employed in the formula. The equivalent of potassic bromide is 119·20, and that of silver nitrate 170.

It is advisable, in framing a formula, to set down the proportions thus:

Potassic bromide	125
Silver nitrate	170

Take one ounce of distilled water, add to it Nelson's No. 1 photo-gelatine, fifteen grains. In this dissolve the potassic bromide, and after allowing the gelatine to swell, dissolve by heat at about 140° Fahr. When the solution is effected, introduce the silver nitrate in crystals, and dissolve. Now boil for twenty minutes, or for an hour if extreme rapidity is desired. It is, of course, necessary to conduct the operations under a chemically inert light from the stage when the silver bromide is formed. After boiling, add to the solution acetic acid (glacial) slightly in excess of the quantity required to dissolve the gelatine. The emulsion thus formed should be made up to a pint with distilled water, and allowed to settle for three or four days. At the end of that time it will be found that the silver bromide has settled down into a compact mass at the bottom of the jar. The water may now be drawn off by means of a siphon, so as not to disturb the sediment.

We recommend that the silver bromide should be again diluted with water, and allowed to settle. This second precipitation removes any trace left of free salts, and should be carried out when the emulsion or plates are to be kept for a length of time.

The silver bromide may be dried finally, and stored in light-tight bottles ready for use. After the second washing, add to the emulsion dilute ammonia drop by drop, and test with litmus paper until all trace of acid is removed. The emulsion should now be made up for use by adding:

Gelatine	150 grains.
Water	5½ ounces.

Complete mixture must be established by vigorously shaking the bottle containing the ingredients. The emulsion should finally be filtered, and plates coated in the ordinary way.

Collodion emulsion may be made by mingling the silver bromide with plain collodion; but, as we have not yet verified this point by actual experiment, we cannot set down definite details of the method to be followed.

We should suggest, however, that a larger proportion of gelatine might be added with signal advantage to form the gelatino bromide of silver, so as to impart greater penetrability to the collodio-gelatino emulsion film.—*Photo. News.*

ON THE CONNECTION OF THE MOLECULAR PROPERTIES OF INORGANIC COMPOUNDS WITH THEIR ACTION UPON THE LIVING ANIMAL ORGANISM.

By James Blake, M.D., F.R.C.S.

During my prolonged researches on the phenomena elicited by the direct introduction of inorganic matter into the circulation of living animals, I have arrived at results which, as I believe, open a new path to the solution of certain riddles of molecular chemistry. The researches were begun with the intention of applying these simpler and better known substances for the analysis of physiological facts, but in the course of my experiments it became clear that living matter might serve as a means for giving a clew to the molecular properties of inorganic matter. In a discourse delivered in 1839 before the Academy of Sciences of Paris, I showed that when solutions of different salts are introduced into the blood of living animals the physiological action depends on the electro-positive component of the salt, and little upon the acid with which it is combined. A communication which I read at a meeting of the Royal Society in June, 1841, proved that the action of inorganic bodies introduced directly into the blood of living animals depends on their isomorphous relations; and in a memoir communicated to the California Academy of Sciences in 1878, I showed that among the compounds of the metallic bodies, strictly speaking, the physiological efficacy of substances belonging to one and the same isomorphous group was proportionate to their atomic weight; the greater the atomic weight the more intense the physiological action. This is not the place to enter closely into the physiological action of the bodies employed in these experiments. They included salts in 41 elements, and their action was tested upon horses, dogs, cats, rabbits, geese, and hens with identical results. Aqueous solutions of the different salts were injected into the blood-vessels of the living animals. Among those of the monatomic metals were salts of lithium, sodium, rubidium, thallium, calcium, and silver. They all agree exactly in their physiological action. The fatal quantity of lithium sulphate for a rabbit is 1 grm. per kilo of the animal's weight; while of silver nitrate, 0·06 grm. was fatal. Among the diatomic metals tried were salts of magnesium, iron, manganese, cobalt, nickel, copper, zinc, and cadmium, as also calcium, strontium, and barium. In the salts of the magnesium series, the analogy of physiological action is very manifest, and their activity is enhanced with the increase of the atomic weight, rising from 0·97 grm. per kilo for magnesium sulphate to 0·08 grm. for cadmium sulphate. The salts of calcium, strontium, and barium form likewise a group in which the increasing physiological action is very distinct, being 0·47 per kilo in calcium chloride and 0·043 grm. per kilo for barium chloride. The physiological reactions of the lead salts resemble those of the barium group, though agreeing in certain reactions with the salts of silver. (Similar transition-reactions were observed in the salts of magnesium, calcium, silver, and gold.)

Among the tetratomic metals, the salts of thorium, palladium, platinum, osmium, and gold were examined. All showed great similarity in their physiological action, ranging from 0·029 grm. per kilo in thorium sulphate to 0·003 grm. per kilo in gold chloride. The decided and characteristic effect of this class of substances upon the action of the heart was shown in the most surprising manner by the compounds of gold, which even in the minute dose of 0·003 grm. per kilo kept up the action of the heart for several hours after death, though the temperature of the body had sunk 13° below the normal heat of the animal.

Among the hexatomic metals, the salts of glucinum, aluminum, and iron (ferricum) agree perfectly in their physiological reactions. The fatal dose per kilo ranges from 0·023 in glucinum, 0·007 for aluminum, and 0·004 grm. in ferricum, all in the state of sulphates. The physiological action of glucinum confirms the view that glucinum is a hexatomic metal.

Among the rarer earths, experiments were tried with ytterbium, cerium, didymium, lanthanum, and erbium. There was found a marked difference between the cerus and ceric salts as in those of iron. The difference is, however, less, being 1 : 3 in cerium and 1 : 28 in iron. Among the non-metallic elements, compounds of chlorine, bromine, iodine, phosphorus, arsenic, antimony, sulphur, and selenium were examined. Chlorine, bromine, and iodine agree closely in their physiological reaction, but instead of an increase there is here a decrease in intensity. Phosphorus, arsenic, and antimony do not induce any immediately perceptible physiological reaction. Arsenious acid, injected in the proportion of 0·560 grm. per kilo, checks the pulmonary circulation. Sulphur and selenium are similar in their action, the latter being the more powerful. The only exceptions to the rule, that isomorphous substances act in an analogous manner, are the salts of potassium and ammonium. The latter produce results resembling those of certain nitrogenous alkaloids. If the carbon compounds exhibit similar phenomena in their manner of action upon the living animal body, researches concerning molecular relations will be greatly facilitated. Dujardin has already demonstrated in this direction, that in alcohols of one and the same series the intensity of the physiological action is directly as the atomic weight.—*Berichte der Deutschen Chem. Gesellschaft.*

PYROXYLINE VARNISHES

Parkes, of Birmingham, has patented the manufacture of varnishes from pyroxyline. According to his method, pyroxyline is dissolved in a mixture of carbon tetrachloride and camphor, which is also mixed with gum, resins, oils, coloring matters, etc. Carbon bisulphide and camphor form also a good solvent. A mixture of camphor with benzole or turpentine, with coöperation of pressure and heat, also dissolves the pyroxyline quickly. These solutions make very good varnishes.

HENNA LEAVES AND POWDER FROM LAWSONIA ALBA.*

By Dr. HEINRICH PASCHKIS.

UNDER the name "henna al henna" ("chenna") a powder is used by Persians, Arabs, and Egyptians, as a cosmetic, which I have submitted to a close investigation.

For this purpose I used three specimens, one of which had been for a long time in the Pharmacological Institute of Vienna; another had been recently sent there by Dr. Polak; the third was kindly furnished to me by Professor Dr. J. Neumann (the last was obtained from the Persian Embassy). All three specimens corresponded with one another both in appearance and microscopical features. The henna powder is greenish brown, tolerably uniform, feeling somewhat sandy between the fingers. In the glass vessels in which it has been preserved for a long time it has acquired upon the surface, under the influence of light, a reddish tinge. Microscopically examined it was recognized as a powder of *Lawsonia* leaves rendered somewhat impure by foraminiferous sand. The general elementary forms which are described subsequently, as well as entire leaves and abundant crystals of oxalate of lime, were also found in it.

Of the leaves themselves I have had two kinds before me, one coming from Persia, the other from the French colony of Senegal; the former was placed at my disposal by Herr Prof. Vogl, the latter by Dr Moeller. The Persian leaves correspond with two herbarium specimens of *Lawsonia alba*, Lam. (*L. spinosa* and *L. inermis*, Linn.) in the Pharmacological Institute in Vienna, and with those of *L. spinosa*, except some variation in the size. The Senegal leaves are only distinguishable from the others by being larger (1 to 2 centimeters longer). The Persian leaves are ovate, acute, mucronate, disappearing at the base into the short petiole. In length they attain 2 centimeters; their greatest breadth is 1 centimeter. The margin is entire, somewhat revolute. The coriaceous shining upper surface is greenish-brown; the under side is rather lighter colored. There is one principal nerve, the lateral nerves anastomosing not far from the margin.

The epidermis of the upper side consists of polygonal cells, crowded together, leaving between them an extraordinary number of stomata. Among the epidermis cells occur, in tolerable abundance, but irregularly distributed, single cells which are remarkable on account of their size (0·033 mm. by 0·018) and the strongly refracting property of their contents (mucilage). These appear equally striking in a transverse section of the leaf. The mesophyl consists under the upper surface of a double palisade layer, and

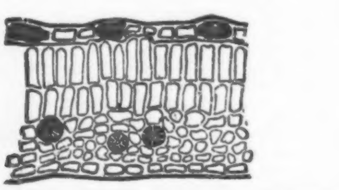


FIG. 1.—LAWSONIA ALBA—TRANSVERSE SECTION.

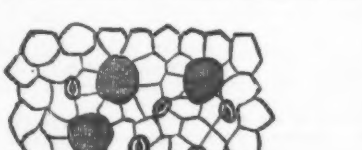


FIG. 2.—UPPER SURFACE.

below that of cells containing chlorophyl crowded together. (Figs. 1 and 2). Among these cells occur numerous rosettes of oxalate of lime. The epidermis of the under side scarcely differs from that of the upper; an almost equal number of stomata occur in it. In solution of potash a section assumes uniformly a beautiful yellow color. Chloride of iron reveals in the mesophyl a tannin turning green with salts of iron; the epidermis cells also, with the exception of the before-mentioned protoplasm cells, easily turn green. The microscopic sugar test gives a negative result; as also treating with chloride of zinc, which only colors the epidermis violet. Leaves kept a long time in alcohol became a somewhat pale reddish color; under the microscope, sections treated with potash solution appeared of a very beautiful delicate rose color. The Senegal leaves scarcely differed in structure from the others.

For the purpose of chemical investigation, 50 grammes of the powder were digested with 1 liter of water, filtered, and the filtrate evaporated to dryness, forming a dry extract, dark brown in color, bitter tasting, and smelling of caramel; a specimen gave sugar when tested. A very small portion of the extract was soluble in alcohol with a yellow-brown color. In ammonia the greater part was soluble, with a beautiful Malaga brown color.

The residue from the treatment with water was digested with 96 per cent. alcohol, filtered, the filtrate concentrated by distillation, again filtered (the residue consisting of black viscid drops, containing wax and chlorophyl), and then evaporated in the air. The supernatant water was poured off. The fine granular wood-brown residue was afterwards dissolved in hot alcohol; after cooling, and remaining some time another small quantity of odorless and tasteless dark brown residue remained, which behaved as described of the last residue. The last alcoholic solution gave upon evaporation a brown resinous mass, which in a suitable quantity of alcohol was soluble with a golden brown color, and could be diluted with water, showing a slight turbidity. It was decolorized by hydrochloric or nitric acid, and became a very deep brown color with solution of ammonia or soda. This substance was further scarcely soluble in cold water, and only to a small extent in hot water (the dirty yellow turbid solution being colored blackish-green with chloride of iron). In benzine, carbon bisulphide, amylic alcohol, ether, and chloroform it was partially soluble, and in petroleum spirit and turpentine almost insoluble. The alcoholic solution, diluted with water, gave the following reactions. With hydrochloric acid, an opalescent turbidity, nitric acid, a yellowish turbidity; chromic acid, a dirty yellow-brown turbidity; caustic soda or ammonia solution, a clear dark Malaga brown; stannic chloride, dirty greenish yellow rusty brown flocculent precipitate; solution of alum, a dirty yellow turbidity; chloride of iron, dark greenish brown; lime water, turmeric yellow, with a slight brownish precipitate; chloride of lime, light yellow, with a slight brownish precipitate; cyanide of potassium, citron yellow, clear; acetate of copper, sea-green, with a slight red-brown precipitate.

This last resinous mass and the above-mentioned residue were washed frequently with hot water, and then completely dissolved in boiling ether. Upon the evaporation of the ether there was obtained a very acrid mixture of two resins; one an acrid soft resin; the other a hard resin, appearing under the microscope in turmeric-yellow scales. The wash-water, which was of a beautiful flesh red color, contained tannin (colored green with chloride of iron) and coloring matter (becoming intensely brown with ammonia or soda solution), the separation of which in such small quantity was impracticable.

In a second experiment 25 grammes of coarsely powdered leaves were mixed with caustic lime—upon which they gave off a very disagreeable odor resembling trimethylamine—and dried. The product was digested with alcohol, filtered, the lime precipitated with sulphuric acid, the liquid concentrated by distillation, again filtered and soda solution added to an alkaline reaction. A slight turbidity resulted, and as the liquid did not clear, it was shaken with amylic alcohol, and the greenish-yellow solution in amylic alcohol evaporated. Placed in a watch glass there shot out some very delicate tufts and needles of brownish-yellow crystals, which dissolved in water and separated again from the aqueous solution in the same form. These crystals were evidently only sodium salts, which separated out from the water removed with the amylic alcohol.

Lastly, 100 grammes of powder* were digested with potash solution and water with heat and the infusion distilled. The water clear distillate showed distinctly an alkaline reaction, and had a very disagreeable smell. It was reduced to one-half by redistillation and the resulting strongly alkaline liquid was treated with dilute sulphuric acid and evaporated upon a water-bath. The liquid, at first water clear and colorless, assumed, upon warming, a tint of rose red, and at the close was of a brownish color; but at this temperature it could not be brought to dryness. Upon the advice of Professor Schneider, the small quantity of liquid was neutralized with potash solution, which caused considerable effervescence; there was given off, at first, an indefinite disagreeable (aromatic) odor, and then a clearly ammoniacal pungent vapor, having a strongly alkaline reaction. The liquid, diluted with distilled water, was now again submitted to distillation; and the vapor conducted into a well-cooled receiver moistened with hydrochloric acid. A dense white mist was developed. The distillate was then evaporated at a very low temperature upon a water-bath, when there resulted a white deliquescent, faintly ammoniacal smelling salt. A portion was dissolved in a very small quantity of absolute alcohol, which upon evaporation left it as a white deliquescent salt similar to that previously obtained. A portion of this latter product treated with solution of potash gave off at first a penetrating fishy smell, which was very similar to that of trimethylamine, gradually passing into a pure ammoniacal odor. The solution with caustic potash became, after standing a few minutes, a delicate rose color. These phenomena, I think, I may refer to a volatile, easily decomposable amine base, if not directly to trimethylamine. The preparation of it in a pure state and in sufficient quantity and its analysis being impracticable with the small quantity of material at my disposal, I reserve its further investigation until subsequently.

Henna has been in use among orientals from the most ancient times until the present day for coloring the finger nails, the soles of the feet, and palm of the hands; also the points of the beard, and the hair. As to the method of producing the dye statements differ. According to a communication made to me orally the powder is stirred with water to make a paste, and this is spread directly upon the place to be colored, which is thus tinged orange-red. Experiments that I have made upon myself lead me to doubt the activity of a paste so prepared. My finger was only soiled, but not colored. With some alkali, however, I obtained, not a yellow or a red, but a brownish color, which corresponded with my experiments. In the dyeing of hair black, the henna should be used in combination with indigo, an innocent, if not very handsome, dyeing material.

Finally, it may be mentioned that in the East the ends of the manes and tails of old horses are colored red with henna. Besides this, henna is used in India as "mayndie," in the dyeing of leather, and in recent times, in France, for the dyeing of silk.† Further, the root is used in pharmacy, as "red alkanna," for coloring ointments and pomades.

The earliest and, at the same time, clearest notice of the use of henna I find in Prosper Alpinus,‡ who, under the designation, "Ligustrum Ægyptium, Elhanne vel Tamarhendi," gives a very good figure and description of the plant. He says, "They make from the leaves a powder which is called 'archenda.' This the women use as a beautifying material, by staining their hands and feet with it of a golden yellow color. Not by mixing with the juice of Lanaria or of Struthium, but simply with water, they produce a golden yellow water which dyes the same color. If our women had used this substance for rendering their hair golden (*pro de aurandis capillis*), which might be used without injury, they would not have allowed their heads to be singed by the sunbeams and injured in every possible way." According to him, also, the powder is used for sweaty feet, and for ulcers of the mouth, gums, and genitals, and the flowers are used as a remedy against headache. Similar statements occur in Loureiro§ and in Vietz‖. Finally, in a more recent work¶ I have found statements that correspond with those of old Alpinus. In India the plant is used as a remedy against all possible diseases and also as a dye material. For this latter purpose the powdered leaf is made into a paste with catechu.**

* Reprinted from the *Zeitschrift* of the Austrian Pharmaceutical Association.

* This quantity was supplied to me by the kindness of Dr. A. Braun. The microscope showed in this, as in all the other powders, an enormous admixture of sand. A preliminary incineration gave more than half (62 per cent.) of incumbustible residue.

† Wiesner, "Rohstoffe des Pflanzenreichs," p. 674.

‡ "Historia Ægypti Naturalis," written in 1592, pub. Lugd. Batav., 1735, Pars. ii., De Plantis Ægypti, p. 23, cap. xiii.

§ Loureiro, "Flora Cochinchinensis," Berlin, 1793, p. 291.

‖ Vietz, "Icones Plantarum," Vienna, 1818, vol. vii., p. 70.

¶ Drury, "Useful Plants of India," p. 285.

** Dymock, "Notes on Indian Drugs," *Pharm. Journ.* [3], vol. ix., p. 894. After an historical notice which goes back to Solomon, Dymock gives also a notice upon the uses, which corresponds with the above. Synonyms: Mehndee (Hind. and Bomb.); Marutouri, Aivanam (Tam.); Mehedi (Beng.)

RAPID DETECTION OF THE PRESENCE OF WATER IN ALCOHOL AND ETHER.

By CARL MANN.

IF an aqueous solution of 2 parts crystalline tartaric acid is mixed with 1 part of molybdic acid and evaporated to incipient fusion in a porcelain capsule, the deep blue mass which is formed, if heated with 30 to 40 parts of water, yields along with a fixed residue a faint yellowish brown filtrate, holding in solution the citrate of a molybdenum compound, which has the property of appearing deep blue in its anhydrous state, but almost colorless when hydrated. If a slip of filter-paper is steeped in this molybdenic solution (not too dilute) and dried at 100° the blue color reappears with great intensity. The paper, if screened from direct sunlight, retains its color. If it is plunged in pure water the blue color disappears at once, the paper becomes white, and the water is not colored. At 50° the decoloration is instantaneous; at 18° to 20° in two or three seconds, and at 10° in five to eight. With absolute alcohol or ether in a stoppered bottle the blue color of the paper remains unaffected. This reagent for water is not acted on by aceton, aldehyd, methylic alcohol and mixtures of amylic and ethylic alcohol. If plunged in spirit of wine the blue color disappears more rapidly the more water is present.

A CATALOGUE, containing brief notices of many important scientific papers heretofore published in the SUPPLEMENT, may be had gratis at this office.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50, stitched in paper, or $3.50, bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
37 Park Row, New York, N. Y.

TABLE OF CONTENTS.

PAGE

I. ENGINEERING AND MECHANICS.—Testing Exploded Boiler Plates. Communication from S. N. HARTWELL, M.E. 4602
A Simple Gas Motor. 1 figure.—Benier's gas motor 4602
An Improved Dredger. 1 figure.—A new English dredging boat 4603
Worthington Compound Pumps. 2 figures 4603
Wooden pavements in San Francisco 4603
American Milling. By ANDREW HUNTER.—Critical review of recent improvements in American milling.—Advantages of high grinding and fast grinding 4604
Surveying of Mining Claims in Colorado. By RICHARD C. PARKER, C.E.—2 figures 4605
Subterranean Telegraph Cable 4606

II. CHEMISTRY AND TECHNOLOGY.—The Border Land of Chemistry and Biology 4612
Report on Analytical Chemistry. By H. N. MORSE 4612
Glycolic Acid from Sugar. By H. KILIANI 4612
On the Connection of the Molecular Properties of Inorganic Compounds with their Action Upon the Living Animal Organism. 4613
Rapid Detection of the Presence of Water in Alcohol and Ether. By CARL MANN 4613
Henna Leaves and Powder from *Lawsonia alba*. By Dr HEINRICH PASCHKIS.—2 figures.—Sections of *Lawsonia alba* magnified. 4613
Hot Ice.—Hannay's repetition of Dr. Carnelley's experiments with variations.—5 figures 4614
Lohse's Method of Preparing Emulsions 4614
Pyroxyline Varnishes 4614

III. ELECTRICITY, ETC.—New Telephones 4607
The Hertz Telephone 4607
Measuring the Index of Refraction of Ebonite. 1 figure 4607
The Storage of Electricity.—Interesting scientific correspondence.—Sir William Thomson's letter.—Osborne Reynolds' letter a damper to Sir Wm. Thomson's enthusiasm.—Sir Wm. Thomson's reply to Prof. Reynolds.—Prof. Ayrton's reply to Prof. Reynolds.. 4607
Domestic Electricity. 2 figures.—Maigret's electric lighter.—Ranque's electric lighter 4608
Philosophical Society of Glasgow. Paper on the Removal of Aqueous Vapor from the Atmosphere. By J. J. COLEMAN, F.C.S.. 4609
An Experiment with the Induction Balance. 2 figures. Hughes' induction balance applied to prestidigitation 4609
Double Action Mercurial Air Pump. 2 figures 4609
Magical Pitchers and Drinking Vessels. 2 figures 4610

IV. BIOGRAPHY, ETC.—Robert William Bunsen. 1 figure. Portrait. Review of Bunsen's contributions to science. By H. E. ROSCOE 4602
Jean Louis Baudelot, Inventor 4602

V. GEOGRAPHY.—The Basin of the Gulf of Mexico. J. E. Hilgard's paper to the National Academy of Sciences 4600
The Feejee Islands and their Resources 4600

VI. ARCHITECTURE.—Suggestions in Architecture. 2 illustrations. Perspective of a new and quaint English house. First prize medal design for a homestead for 50 cows 4604

VII. ART, ARCHÆOLOGY, ETC.—Central American Antiquities. 7 figures. Aztec Painting of a Law Suit.—Pyramid of Cholula, near Mexico. Mural Painting in Funeral Chamber of the Chaac-Mol Monument at Chichen Itza.—Stone Column found at Capan, Honduras.—Mexican Calendar Stone.—Statue of Chaac-Mol.—Stucco Relief Work found at Palenque 4599
Newly Opened Pyramids in Egypt 4600

VIII. ASTRONOMY, ETC.—Partial Eclipse of the Sun, December 31, 1880. By J. RAND CAPRON. 4 figures 4611
Palmieri's Report Regarding the Observatory of Vesuvius 4611

IX. HYGIENE AND MEDICINE.—Turpentine Vapor in Whooping Cough 4610
New State Insane Hospital, near Norristown, Pa 4610
Rectal Alimentation 4611
Flax as a Carrier of Disease 4611
Charcoal in Hypnotism 4611